A WATER USE ZONING STRATEGY TO REDUCE BIO-PHYSICAL AND SOCIAL STRESS FROM RECREATIONAL BOATING IN THREE SOUTHWEST FLORIDA ANCHORAGES

By

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Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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This research delineates suitable water-use zones for specific recreational boating activities. The methodology incorporates a survey of shore-resident emotional responses, an inventory of bio-physical features, and the monitoring of boating activities at three test sites in Sarasota Bay, Florida. Social and bio-physical data are combined using geographic-information-systems technology. The resulting water-use suitability zones are displayed in map form. Activity monitoring compares observed on-water utilization to derived water-use zones. A comparison of utilization to the suitability of a particular area permits an assessment of that area's vulnerability to recreational boating activities. This information can be useful in support of both regulatory and nonregulatory boating resource management efforts.

CHAPTER 1
INTRODUCTION

Background

Southwest Florida's permanent and seasonal populations are growing rapidly. Much of this demographic growth is occurring in coastal areas (BEBR, 1990; Culliton et al., 1990). Environmental impacts associated with the rapid development of Florida's southwest coast include a significant decline in coastal mangrove, wetlands and seagrass. These natural areas have been replaced by recreational, commercial and shorefront residential development on vast networks of dredged canals. For example, prior to World War II, the Sarasota Bay coastline was virtually undeveloped. In contrast, 78 percent of the Sarasota Bay coastline had been developed by 1990 (Roat and Alderson, 1990). Much of this development can be attributed to artificial residential canals which have increased the bay's shoreline by more than 83 miles (Antonini and Box, 1996). The popularity of boating in southwest Florida has grown commensurately with the regional population. Uninhabited islands, natural shorelines, and a wide variety of marine life combine to attract many boaters to Southwest Florida, which is comprised of Manatee, Sarasota, Charlotte, Lee, and Collier counties. According to the Bureau of Economic and Business Research, boat registration in Southwest Florida totaled 74,538 in 1989, which represents a 309 percent

increase since 1970 (BEBR, 1990). In addition, an estimated 97,628 boats are projected in this area by the year 2000 (BEBR, 1990). Recreational boating and fishing contribute greatly to the economy and quality of life in Florida's southwest coastal areas. For example, boating and fishing-related activities contributed roughly $500 million in 1993 to southwest Florida's regional economy (Antonini et al., 1994).

Bio-physical and social stress[1] resulting from increased boating activities and coastal development along Florida's coastline is illustrated by the current trends in Sarasota Bay. Sarasota Bay planners and resource managers find themselves faced with a need to balance environmental protection and sustainable use. There exists a complex web of interactions or interdependencies among boaters, shore residents and the environment. Shore-resident and boating populations continue to increase. Both populations contribute to increased boat traffic and congestion, which degrades those very environmental features that attracted boaters to the area in the first place. The optimal solution requires a management strategy that balances natural and human-related interactions in a way that does not compromise the quality of life of shore residents, the water-oriented recreational goals of boaters, and environmental quality.

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[1]Bio-physical stress refers to boating activities that compromise activity-specific requirements such as avoiding seagrass beds, maintaining a minimal depth, and anchoring in areas of inadequate bottom holding (see figure3, page 46). Social stress refers to boating activities that compromise shore-resident-tolerance zones, defined by specific distances from the shoreline (see Table 15, page 91).

The escalating use of bay water resources has resulted in increased political pressure from shorefront residents and environmental groups on Florida's policy makers to consider tougher environmental regulations to protect coastal habitat. In doing so, state policy makers have focused on boat travel and anchoring as primary contributors to bay water pollution, seagrass destruction and conflicts with shorefront residents (Antonini et al., 1994; Antonini and Box, 1997). Local governments have enacted restrictions on the length of stay at anchorages, and other types of restrictions are being considered. These regulatory strategies have come under increasing criticism by boaters who argue that the proposed laws are an infringement of their right to sail and utilize open navigable waters for recreational purposes (Rocque and Jones, 1992; Flannery, 1992). As such, boater-advocacy groups, such as the Boaters Information and Action League (BAIL), have been fighting "top down" legislative initiatives by the state to restrict boating and anchoring activities. Their efforts resulted in the recent passage of Florida House Bill 109, in 1993, which requires regulating agencies to present scientific justification behind boating regulations.

Boaters also have the opportunity now to benefit from recent grass roots public pressure against government regulations. This pressure has led federal agencies to, increasingly, pass down regulatory control to state and local authorities. In keeping with the new regulatory climate of "less is better," the Florida Department of Environmental Protection (DEP) outlined , in 1995, an ecosystem-management strategy that emphasizes "environmental stewardship"

and "cooperative partnerships" between regulatory agencies and resource users (Barnett et al., 1995). Local and state officials view this new strategy as a potential building block for the introduction of non-regulatory means for the promotion of the sustainable use of popular anchorage sites.

In 1992, cooperation among the Boaters Action and Information League (BAIL), the West Coast Inland Navigational District (WCIND), the Southwest Florida Regional Planning Council (SWFRPC), the Florida Department of Environmental Protection (FDEP), and the Florida Sea Grant Program (FSG) provided a basis for a non-regulatory approach for identifying, monitoring and reducing the impact of boat activities on sensitive Southwestern Florida coastal areas.

The Cartographic Research Laboratory (CRESLAG) at the University of Florida, working through FSG, was contracted to work with program partners in developing a five-year implementation strategy to test the feasibility of a non-regulatory approach to anchorage management (Antonini et al., 1994). An important goal of this pilot program is to use education, in the form of detailed anchorage guidebooks, public meetings, and peer pressure, as the mechanism to instill desirable anchoring and boating practices. A long-term survey of area boaters by Antonini et al. (1994) confirmed that education within the boating community can be a powerful tool to improve waterway management. Equipped with better information, it is hoped that boaters will act with greater responsibility towards and awareness of their surroundings.

A Regional Harbor Board (RHB) has been established to implement the non-regulatory management plan by addressing resource problems using a conflict resolution approach rather than a regulatory one. However, the RHB is empowered to designate anchorages in need of active management based on demonstrated environmental damage or chronic user conflict or overcrowding.

Towards this end, the pilot program incorporates anchorage site monitoring to allow the RHB and resource managers to identify sites that are prone to environmental degradation and / or social conflict, thereby qualifying for a more pro-active management strategy (Antonini et al., 1998).

Many Southwest Florida municipalities, including Bradenton, Cape Coral, Ft. Myers Beach, Punta Gorda, Sanibel, Naples, and Venice, have agreed to temporarily suspend their current regulatory policies regarding length of stay in favor of non-regulatory methods that include citizen-run local harbor boards as conflict mediators monitoring of popular anchorage sites, and boater-education programs.

Boaters and policy makers alike agree that additional scientific work is needed to describe and measure social and environmental interactions and conflicts at frequently used anchorage sites. Scientific studies, according to the *Ecosystem Management Implementation Strategy* developed by the Florida Department of Environmental Protection, should build upon a basic understanding of the relationships between users and resources (Barnett et al., 1995).

In order to meet Sarasota Bay's current anchorage management needs, this research seeks to develop and test the validity of a water-use classification strategy that delineates boating water-use zones for three popular anchorage sites, -- Island Park, Otter Key, and Longbeach, -- in Sarasota and Manatee Counties (see Figure 1 for site locations). In addition to recognizing the interconnectedness of the physical and social elements of an anchorage site, the proposed water-use-zoning strategy will build upon a non-regulatory framework developed over the past several years through the collaboration of BAIL, WCIND, SWFRPC, FDEP, and FSG. The implementation of this strategy will (1) include the monitoring of on-water activities, (2) incorporate a shore-resident survey to quantify social attitudes towards proximate boating activities, and (3) include an inventory of the bio-physical characteristics of the anchorage site. Water-use zoning maps are derived from integrating the bio-physical, social, and boating-activity components with the anchorage[2] geography. Water-use zones offer bio-physically and socially acceptable locations for on-water boating activities. The results can be used by resource managers as a means of facilitating boater education with the intent of reducing social conflict and bio-physical impact at popular, near-shore recreational anchorage sites.

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[2]An anchorage is defined as a near-shore site where recreational anchoring and other activities, such as, fishing, sailing, power boating, and jet skiing, commonly occur. The most popular anchorages offer deep water, good anchor holding, and protection from winds and strong tidal currents. Many are also lined with expensive homes and / or natural coastline. Anchorages have been classified by Antonini (1998) as urban, suburban and rural, based on surrounding land uses and land cover.

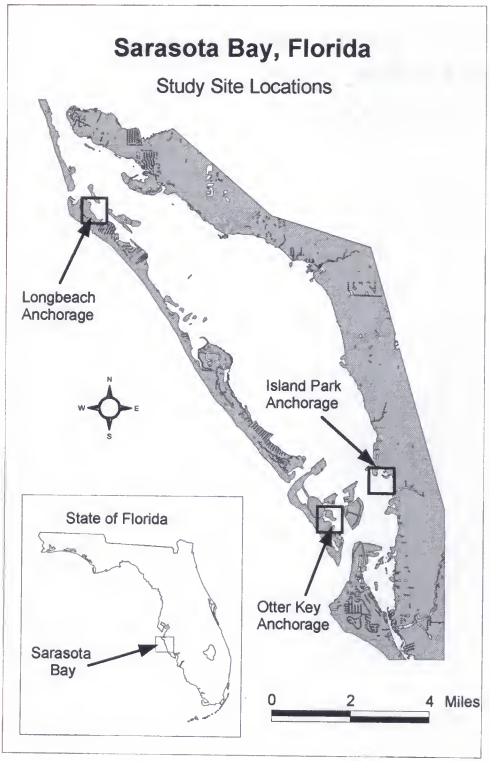

Figure 1. Sarasota Bay Region and Study Site Locations.

Specific Aims

The development of a water-use-zoning strategy for an anchorage site requires a knowledge of the basic relationships between the users and the physical resources. In keeping with these requirements, the research aims are: (1) to define and characterize recreational boating activities; (2) to develop a set of criteria for delineating homogeneous bio-physical zones for specific boating activities occurring within an anchorage site; (3) to develop a set of criteria delineating social-tolerance zones for specific boating activities occurring within an anchorage site; (4) to integrate bio-physical and social-tolerance zones to delineate boating water-use zones within an anchorage site; and (5) to monitor and describe the location, frequency, spatial extent, and type of boating activities in selected recreational anchorage sites. I will provide a means of comparing observed utilization with derived social tolerance and bio-physical zones.

Scope of the Research

The goal of this research is to provide a basis for identifying water-use zones for specific recreational boating activities. Identified use zones are not intended to be rigid, but rather they are meant to suggest environmentally and socially acceptable locations for on-water boating activities. As such, activity-use zones may overlap, as activities will each be considered independently. Consequently, water-use zones should not be used as the basis for reducing

conflicts between boaters through the spatial segregation of potentially incompatible activities. A study of boater attitudes would be required to determine the compatibility of specific recreational-boating activities.

It is acknowledged that the social and environmental views of boaters are essential to a comprehensive understanding of the social geography of an anchorage site. However, for the purpose of this study, it is assumed that recreational boaters are mobile, and therefore they have the opportunity to act and adjust their locations. Thus, a boater's response to outside stimuli and his/her subsequent activities can be "self regulating" (Box, 1997). Conversely, shore residents, seagrass, and the other selected bio-physical features of the anchorage are more or less fixed and therefore have little opportunity to make adjustments.

This research focuses on mitigating conflict and deriving recreational water-use zones from the perspective of the more permanent elements of the study site. Many social (shorefront residents, boaters, regulations, use intensity, access), physical (size, shape, bottom type, bathymetry, water flow), and environmental (surrounding land cover, erosion, seagrass, water quality, aquatic flora and fauna) elements define and characterize an anchorage site. However, only those more tangible anchorage-site elements identified (through mail surveys and focus group interviews) as most important by Antonini et al. (1994) were selected for this research. These elements include shorefront residents, bathymetry, bottom type and seagrass. Other elements, such as manatee

impacts, water quality and erosion also are considered to be major boating-related problems. However, cost and time limitation prohibits the measurement of these variables in this study. Several years of "site-specific" monitoring would be required to assess the relative impact and source of pollutants or wake on water quality and shoreline erosion. For similar reasons, manatee impacts are not directly considered in this study. However, it is recognized that sea-grass beds are considered manatee and fish habitat. It is therefore assumed that a water-use zoning strategy that redirects boating activities from seagrass beds will indirectly reduce manatee-habitat conflicts.

Tour boats and flat-bottom commercial shrimp boats have been identified as possible contributors toward seagrass destruction (Antonini et al., 1994). However, according to the same study, recreational boating activities present by far the greatest source of daily frustration for shore-front residents (and perceived environmental problems) in small, near-shore anchorages (Antonini et al., 1994). Because of this concern of shore-front residents, the research will focus solely on recreational boating activities, including anchored live-aboards, transient anchoring, sailing, power boating, fishing and jet skiing.

Rationale

Extensive literature exists on applied coastal and recreational zoning techniques. Topical areas focus on public-policy issues including regional coordination and implementation (Owens, 1985), of the management of land-

side residential, commercial and industrial development (Healey and Zinn, 1985). Specific applications of zoning include mitigating environmental impacts such as beach erosion and habitat loss resulting from hotel and condominium development (Beatley, 1994; Welch and Remillard, 1992) and planning and gauging the impact of existing and future marina, public-boat-ramp and private dock development (Antonini et al., 1997). Much of the relevant literature on coastal recreational water-use zoning seems to dry up at the water's edge.

Water-use zoning on lakes and reservoirs is considered, in theory, to be an appropriate method to reduce on-water-recreational-user conflicts and environmental degradation (Wilson, 1964; Jaakson, 1970, 1971, 1984; Brown et al., 1979). However, this long-standing approach to land-use management has, to date, been rarely considered and scientifically applied to recreational water-uses.

Previous applications of zoning to recreational water-use have been theoretical and or limited in scope with the focus on mitigating specific activity conflicts such as commercial and recreational boating (Heatwole and West, 1982), swimming, fishing, and water skiing (Wilson, 1964; Jaakson, 1971), or the environmental impacts of jet skis on sail boaters and avifauna (Cuthbert and Suman, 1995) . Past efforts have not holistically combined both environmental and social components. Except for Antonini et al. (1990) and Sesto (1992), previous research on water-use conflicts and water-use zoning has not considered the impacts of water-based activities on shorefront residents.

The water-use-zoning strategy presented here integrates bio-physical and social criteria by utilizing geographic-information-systems (GIS) and global-positioning-systems (GPS) mapping technologies for the collection, management, analysis, and display of data. The use of GIS as a tool for land-based planning is well established, but "applications in coastal and aquatic environments are less common and less well defined" (Ricketts, 1992; p82). Garcia and Kapetsy (1991) have identified as fertile areas for the application of GIS technology to coastal and ocean management (1) supporting statistical modeling and impact analyses, and (2) improving visualization of data for space-use management. This research endeavors to fulfil these identified needs.

In short, this research strives to provide a more holistic, systematic and map-based approach to recreational water-use zoning that can be used to gain a better understanding of the relationships between water users, shorefront residents and the natural environment. It endeavors to provide a useful methodology and site-specific information to facilitate management decisions aimed at reducing bio-physical and social stress at popular anchorages.

CHAPTER 2
LITERATURE REVIEW

The focus of the research is the development of a water-use-zoning strategy to reduce social conflict between boaters and shore residents and to reduce environmental impact on seagrass beds. The main purpose of the literature review is to define and place this research within the broader, relevant literature concerning social conflicts and environmental impacts as they relate to recreational water use and, more specifically, to Southwest Florida and Sarasota Bay. Previous water-use-zoning literature also will be reviewed. The literature review is divided into three sections: (1) water-use zoning; (2) environmental-impact studies; and (3) shore-resident-conflict studies.

Water-Use Zoning

Zoning is a traditional regulatory power applied by local governments as a mechanism to mitigate the negative effects of incompatible activities that are in close proximity. It is most often thought of as a regulatory tool to promote or maintain land values and the public health, safety and welfare through the strict control and management of individual land uses (Lai, 1988). Implicit in the concept and historical application of zoning is the elimination of negative environmental impacts and social conflict through the separation of incompatible

land uses. Zoning regulation has its roots in the English common law of nuisance. In the United States, the concepts of comprehensive planning and zoning arose and became widely applied in American cities as important land-control mechanisms supporting large-scale gentrification and urban renewal projects. Some planners suggest that it has been applied as a regulatory mechanism for the protection of upscale-single-family residential enclaves from the encroachment of industrial, commercial and multi-family uses (Mandelker, 1971).

The right of individuals to utilize their property to its greatest potential is a fundamental American tradition. The use of public police power, in the form of zoning regulations, to restrict individual property uses to what the majority deems acceptable is, therefore, a controversial topic. Some legal analysts argue that the practice of zoning is inherently discriminatory in that regulations are made to protect and promote the land values and traditions of the dominant political culture (Lai, 1988; Beatley, 1994). Consequently, the misuse of zoning can result in racial and / or economic segregation. More recently the traditional use of zoning has also come under fire for having the unintended effect of promoting unsafe and unsightly development and environmental destruction by fostering monotonous, low-density land-use patterns that virtually require automobile use (Beatley, 1994).

The conditions that prompted the widespread application of land-use-zoning practices is beginning to exist on coastal waters. However, the

implementation of zoning techniques to the water is complicated by legal precedent that historically ensures the right of the public to free and unimpeded navigation on all navigable waters within the United States (Ditton, 1977). Additional problems related to the direct application of land-use zoning to the water include the transient nature of competing boating activities and the difficulty of defining appropriate boundaries on a uniform waterscape (Field and Martinson, 1986). Water depth provides a physical barrier, separating activities that require deeper water (power boating, water skiing) from activities such as swimming (Jaakson, 1971). Nevertheless, the flat, open nature of water makes it difficult to separate incompatible uses by means other than distance or time (Field and Martinson, 1986).

Extensive literature exists on coastal-oriented zoning, but the focus is on land-side activities, such as the use of zoning to promote current and future land-use planning for waterfront residential, commercial and industrial development (Beatley, 1994) or to assess the projected demands for and environmental impact of new marinas, boat ramps and private docks (Antonini et al., 1997). One clue to the scarcity of relevant research on recreational water-use zoning may lie in the time required to conduct shore-resident interviews and the cost and logistical difficulties inherent in a systematic underwater survey (Albers and Dobbin, 1991; Antonini et al., 1992; Murphy and Smith, 1995).

One of the earliest water-use-zoning efforts to develop a theoretical framework for determining optimal lake use is outlined in "Some Spatial Aspects

of Aquatic Recreation" by Threinen (1961). Here, Threinen identifies water-surface zoning as an appropriate means to optimize the use of lake resources:

> Zoning is common for highways and lands in cities for certain uses. There is no reason why the shores and lakes should not be treated similarly. Zoning is basically a use of the police power exercised in the name of health, safety and welfare. Welfare of the lake community will be best served by this method (Threinen, in Wilson, 1964; p11).

Threinen holds that zoning for optimal use requires a determination of the activities and purposes that are best suited to the environment of a specific lake. In other words, his zoning strategy is based on the premise that uses must be compatible with the physical geography of the lake. In keeping with this, Threinen characterizes lakes for their recreational-use potential based on broad, bio-physical characteristics, such as size, aquatic diversity and shore-front development. He concludes that small lakes (less than 100 acres) tended to be rather sterile and swampy (little wave action, heavily vegetated, lacked deep water and a diversity of aquatic life), which makes them less desirable for residential development and recreational pursuits. Medium sized lakes of 100 to 1,000 acres have greater wave action and depth, which prevents the establishment of marsh vegetation and allows for sandy beaches and a mixed fishery. These factors, according to Threinen, combine to create an ideal environment for development and recreational-boating pursuits. He also considers lakes greater than 1,000 acres in area as "prime" from a residential-development standpoint but less than optimal for some boating activities due to

higher winds and greater wave action. For instance, due to potentially windy conditions, Threinen maintains that additional protection is required on very large lakes for boats moored in anchorages or at piers.

Threinen's theoretical framework is more fully developed by Wilson (1964) who applies a more scientific approach to the analysis of optimal lake use. Like Threinen, Wilson suggests an inventory of the bio-physical characteristics of the lake as a key first step in the development of a water-surface-zoning strategy. However, Wilson's geographic inventory is expanded and includes precise measurements of the length and width of the shoreline, widest and narrowest points, depth, shorefront land use, water access, flora and fauna, weeds, algae, and pollution. In addition, Wilson's methodology incorporates an aerial survey of recreational boaters to identify the most common uses and activities occurring on a lake. From this information, Wilson estimates general-activity space requirements for identified uses such as power boating, water skiing, fishing and sailing. Wilson suggests that the minimum space requirements for mixed boating activities, such as slower moving power boats and sail boats is between 5 to 10 acres per boat. High-speed power boating and water skiing require a minimum of 20 acres per boat while fishing is determined to require a minimum of one acre per boat.

Wilson provides general-use densities based on the space requirements of activities and the physical and social characteristics of the lake shoreline. For example, Wilson suggests that lakes less than 50 acres in area be limited to

boats without motors. Larger lakes, he maintains, can accommodate higher intensity boating. However, Wilson reasons that speed zones may be required to reduce use conflict and noise on lakes "whose shores have complex shapes or are completely occupied by residences and recreation facilities" (Wilson, 1965; p 17).

The approaches of Threinen and Wilson can be applied generically to any lake. Lucas (1962) proposes a site-specific yet regional application of water-recreation zoning. Rather than zoning individual lakes, Lucas uses a survey-response method to propose a concentric zoning strategy for the entire Quetico-Superior Area, which is 3,371 square miles and comprises many lakes. Each zone is derived on the basis of the degree to which survey respondents considered an area to be "wilderness". A survey of boaters revealed that canoeists were highly sensitive of nearby motor boating activities and that motor boaters "view a much larger area as wilderness than do canoeists" (Lucas, 1962; p333). As such, Lucas posited:

> It appears that if future recreational use could be zoned concentrically more than it is now the satisfaction of canoeists, who are more sensitive to crowding and competition, could be increased without decreasing the satisfaction of the other, less sensitive motor boating visitors (Lucas, 1962; p332).

Lucas recommends three concentric zones: An outer general recreation zone (for all activities); a middle wilderness motorboat zone; and a core area designated for canoeists and others who seek greater solitude from noise and

crowds. Lucas concludes that concentric zones, which are increasingly restrictive towards motorized activities as one travels deeper into unpopulated, back country areas, would help maintain a quality "wilderness" experience for canoeists as well as motor boaters.

Jaakson (1971) offers an application of water-surface zoning by expanding upon the concept of concentric lake zoning first proposed by Lucas (1962). While Lucas developed a regional strategy that grouped many lakes into each zone, Jaakson focuses on dividing individual lakes into several water-use zones. Jaakson expands Lucas' method to include additional recreational uses as well as environmental parameters. The key issue, according to Jaakson, was to "divide incompatible activities into groups which exhibit similar characteristics and which take place under similar circumstances" (Jaakson, 1971. p383). To accomplish this segregation of boating activities, Jaakson recommends the spatial segregation of like activities on the basis of use, type and intensity. For example, the high speed associated with power boating and water skiing necessitates the segregation of those activities from swimming and wading.

Jaakson also encourages the segregation of higher intensity, motorized boating from less intensive or non-motorized boating pursuits, such as fishing or canoeing. However, Jaakson cautions that "every on-water activity can not, and in fact does not have to be segregated from every other activity. An attempt to do so would create such a proliferation of activity zones that restrictions would

be meaningless" (Jaakson, 1971; p383).

Jaakson's strategy also departs from past research in that he argues for the clear identification of the environmentally sensitive biotic communities of a lake. Toward that end, Jaakson identifies "the shallow water [five feet or less] in which aquatic vegetation can be present on the bottom as the most vulnerable section of a lake to the effects of [high intensity] recreation," namely, power boating and water skiing (Jaakson, 1971; 385). The extent of both the wildlife and shoreline activity zones are determined by the five-foot-depth criterion, "since for recreation it forms the limit where most swimming, wading, and other beach activities take place, and since for the ecosystem of a lake it delineates an area where aquatic vegetation is abundant" (Jaakson, 1971; p383). In addition, other activity zones, such as power boating and water skiing, are designated by arbitrarily defined distances from the shoreline. In short, though some of Jaakson's zones (vegetation, swimming) are based on somewhat reliable assumptions of depth, his strategy is still encumbered by activity-zone boundaries defined by arbitrary distances from the shore line.

Ashton (1971) employs methods similar to those of Wilson (1964) for the development of "space consumption" and "dispersion" indices to study the relationships between lake-user satisfaction and observed use levels. Like Wilson, Ashton utilizes a grid system superimposed on aerial photography to measure use intensity and boat dispersion over time. However, Ashton first divides the lake into various zones for observation. The total number of boats

involved in each activity was determined for each zone. Ashton then computes precise measurements of boat movement and "wake trails" on subsequent aerial photographs. A computerized model then was developed to obtain a more precise measurement of activity space requirements and boat dispersion by dividing the area of each zone by the total number of boats. The model derived the number of acres utilized by each boat activity type. In addition, Ashton compared the calculated activity space measurements of various boating activities to perceived levels of use and crowding obtained from user surveys. Ashton's model provides a range of capacities for various boat groupings based on a more quantitative, precise estimate of activity space requirements than the method proposed by Wilson.

Similar methods are employed by Heatwole and West (1982) in the development of a surface-zoning technique to separate recreational and commercial boats. Aerial photography and mail questionnaires provided an "understanding of the time and space utilization of the water body by various groups" (Heatwole and West,1982; p308). Survey responses were aggregated into a series of maps that depicted frequencies of use by grid zone for both power and sail boats. This information is then compared to commercial-boat-travel corridors to determine conflict potential.

The appropriateness of recreational-water-use zoning is also suggested by Hammon, et al. (1975) as a method of supplementing carrying-capacity standards. The authors maintain that the water surface of a lake system should

be zoned to accommodate slower, smaller boats and sail boats as they cannot compete effectively for space with larger, more powerful boats (Hammon, et al., 1975; p13). Hammon et al. applied a systems approach to develop a carrying-capacity model for lake recreation. This approach modeled the temporal, spatial, and behavioral interaction among recreation visitors and the lake environment. Boater surveys and measurements of space utilization and use intensity from aerial photographs provided the model input. The Hammon team concluded as follows:

> Managers and planners are continually seeking the magic number called capacity. Supposedly, knowledge of this magic number will solve many management problems. But as a result of in-depth thinking and analysis of user reactions to high levels of boating use, a conclusion is reached which indicates that CAPACITY MAY NOT BE A VIABLE OR VALID CONCEPT FOR MANAGEMENT OF RESERVOIRS for recreational use...lake area zoning or time zoning are a feasible means to separate incompatible uses and increase overall user satisfaction (Cordell et al., 1975; p 97 and 98).

A more recent example by Easley et al. (1989) applies transportation-planning techniques to generate waterway level-of-service (LOS) measurements to reduce boater conflicts in Naples Bay. Level-of-service operating conditions are based on estimates of activity space requirements and site surveys of boat densities, movements, and user perceptions regarding restricted, semi-restricted and unrestricted traffic flow (Burrows, et al.; 1989). A policy-based decision model is created appropriate to each LOS. For example, specific policies –

such as the expansion of shore line buffer zones, enforcement of speed limits and minimum wake limits, and launching quotas – would be implemented to maintain or increase LOS ratings for designated boat traffic zones.

Current water-surface-zoning techniques fall into five broad categories: restrictions on boat speed and horsepower, special-use zoning, time zoning, space zoning, and limited-density zoning (Brown, et al. 1979). Most state constitutions give all citizens equal rights to water use on navigable waterways. As a result, regulatory agencies are reluctant to place an outright ban on boating activities. Speed zoning, in the form of "no wake" zones, is perhaps the most commonly used boating restriction. Sometimes included with speed zones are special-use zones in which specific activities are limited or prohibited. Special-use zones typically are delineated by buoys and include public-swimming zones, no-motor zones, no-boat zones, water-ski zones, and horsepower-limitation zones.

Time zoning restricts use on the basis of the time of day, season, or length of stay. For instance, potentially incompatible activities such as fishing and water skiing are segregated on the basis of time. Time restrictions are relaxed during the times when these activities are most popular. For example, fishing may be permitted during the morning hours and water skiing in the early and mid-afternoon. Another example of time zoning may limit anchoring at one location to 72 hours.

Protective-space zoning "provides for a protective barrier of space

insulating various water surface uses that may be occurring in the same general area" (Brown, et al. 1979; p 340. This technique is commonly used to separate sail boating and swimming areas from power-boating activities. Here, distance buffers are used to insulate slower moving craft and swimmers from fast moving power boats.

A less commonly employed method of separating incompatible uses is through limited density zoning. This technique has been used to limit the number of water skiers on a lake between certain peak times of the day when multiple uses are more common. In this example, several zoning techniques (time and density) are combined.

In addition to these more direct applications of zoning to the water, indirect zoning methods used in Florida -- such as "prohibiting boat launching or not providing support facilities for various water activities" -- also have been found to be effective in regulating water-surface use (Brown, et al. 1979; p 341).

The closed nature of lake and reservoir systems limit recreational activities to a finite space. Consequently, recreational-boating activities reached critical mass on lakes earlier than in coastal waters. For this reason much of the water-surface zoning literature during the 1960s and early 1970s focuses on lake environments at a time when recreational boating on lakes was reaching a level requiring regulatory intervention to improve safety and mitigate increasing conflicts. The concept of limiting recreational boating activities to specific times, densities, or areas is relatively new to open coastal waters.

The federally mandated Coastal Zone Management Act (CZMA) of 1972 focused attention to the nation's developing coastal areas. Rapid population growth, development and increasing use of fragile coastal resources necessitated some form of federal and state intervention. Environmental issues concerning water pollution and the destruction of coastal marshes and wetlands and seagrass also prompted a call for action. Thus, in Florida, the few existent boat-management plans and impact studies have been developed by environmental-engineering and public-planning agencies to be used by coastal communities and counties as a basis for the implementation of the required coastal-management element of state-mandated comprehensive plans. Consequently, much of the work in this area exists as "gray literature," residing outside the realm of academic journals. To date there exists no boat management or impact studies specific to the Sarasota and Manatee County areas.

The "Boating Impacts Management Plan" (Barker and Garrett, 1992) for the Florida Keys, prepared by the Monroe County Growth Management Division, provides the closest geographic "gray" literature example to date of applying water-surface zoning to coastal areas. The Monroe County Growth Management Division's "Boating Impacts Management Plan," proposes "user partitioning" through zoning to "reduce frequent user conflicts which degrade the value of the resource for each other...Conflicts are not only with other users, these simultaneous uses cumulatively impact the natural features and resources

as well" (Barker and Garrett, 1992; p49).

Monroe County planners used a Delphi approach, which included input from dive-industry representatives, recreational-fishing guides, commercial fishermen, environmentalists and scientists. Members for each of these special-interest groups identified restrictive-zone types based on location and the presumed recreational goals and objectives of their constituents. Acceptable and unacceptable activities were defined by each special-interest group for high-use areas. Suggested zones included the following: no air boats, wilderness-no motor, snorkel and lobstering only, and swimming and diving only.

The Delphi-defined, specific zoning types were collapsed into six generic categories. These zoning categories are wildlife-management zones, replenishment reserves, sanctuary-preservation areas, existent-management areas, special-use zones and general-use zones. Multi-year site monitoring is offered as the best means for documenting the effects of the management plan. However, the monitoring strategy was not developed and the implementation and management of the zones was left open.

The Monroe County "Boating Impacts Management Plan" has several shortcomings that typify the problems associated with comprehensively oriented public-planning efforts. Firstly, zoning labels are vague and do not quickly convey the intent to the average boater. Secondly, the evaluation is too superficial in some areas (such as monitoring and implementation) yet often contains volumes of material not seemingly relevant to the stated goals.

A plan for water-surface zoning recently established by the City of Vero Beach, divides the mooring field of the public anchorage into 20 permanent and 22 transient moorings. Permanent moorings may include both anchoring live-aboards and stored vessels. Transient moorings may be rented by the day or month, up to six months. Mooring locations were selected on the basis of providing the maximum physical space for vessel maneuverability and maintaining a safe distance from navigational channels to the docks of a boat servicing center, a private Yacht Club and the Vero Beach Marina (Bursick 1998).

Environmental Impact Studies

Studies isolating the impact of boating on water quality are limited. Such studies are methodologically problematic, as there are numerous non-point sources of pollution such as runoff, and sewage and dumping, which obscure the exact contribution of boater-related pollution (Stevely, 1998). However, by-products of boating activities -- such as emissions of motor oil, diesel fuel, gasoline and turbidity -- have been generally linked to water pollution in aquatic environments (Jackivicz and Kuzminski 1973) and, more specifically, to a decline in aquatic plants in canal ecosystems (Murphey and Eaton, 1983). For example, Murphy and Eaton (1983) quantified the relationship between boat-traffic counts, time and macrophyte (plant) growth. They found an inverse relationship between boat density and plant-life abundance.

Other documented sources of boater-related pollution, including waste

and trash, have been linked to boat live-aboards and large marinas (Heatwole, 1987; Antonini et al., 1990; Sesto,1992). According to Heatwole (1987),

> Concentrations of live-aboard vessels have been found to significantly degrade water quality through discharge of human waste. Coprostanol measurements (an indicator of mammalian excreta) were highest in sediments directly below and around boat slips, indicating that the primary source of fecal material in the basin was the discharge of untreated sewage from live-aboard vessels, even though there were adequate shore facilities available (Heatwole in Schroeder, 1988).

The Heatwole study supports the perception of shore residents that live-aboard activities degrade water quality (Antonini, et al., 1994) and illustrates the resistance of some boaters who do not responsibly use holding tanks or on-shore facilities.

Impacts to avifauna and marine mammals are more visible environmental consequences of coastal boating activities. A relatively new type of intensive water sport, jet skiing, is having profound environmental impacts. According to a recent study, "ample observations exist of jet skis repeatedly flushing birds from critical bird nesting habitats adjacent to shallow tidal creeks where the watercraft operators circumnavigate the islands" (Cuthbert and Suman, 1995: p 133). Thus, there is mounting evidence that jet skis are "causing disruption of roosting, foraging, and nesting avifauna" (Cuthbert and Suman, 1995: p 133).

Increased boating activity also has been responsible for a rise in manatee injuries and deaths (Odell and Renyolds, 1979; O'Shea et al, 1985).

Canal dredging, new housing developments and boating facilities have reduced manatee habitat and allowed greater boat access to shallow waters that are frequented by manatees. It is generally agreed that the propeller and impact wounds from power boats represent the major cause of injuries and death to manatees. Recent studies suggest a link between higher manatee injuries and mortality and increased boat registration (Bond and Beck; 1990; O'Shea et al., 1985). According to Ackerman (1992), boat-related manatee deaths have steadily increased from 21 percent of all deaths in 1976-80 to 29 percent in 1986-91 with higher numbers expected by the year 2000.

While receiving less public interest than manatees, environmentally important seagrass beds are also a victim of boat traffic. Seagrasses provide the foundation of some of the worlds most ecologically productive natural marine communities (Zieman and Zieman, 1989). The importance of seagrass is expressed in a Florida Marine Research Institute (FMRI) technical report, which states:

> Seagrasses are a vital component of Florida's coastal ecology and economy; they provide nutrition and shelter to animals important to marine fisheries, provide critical habitat for many other animals (e.g., wading birds, manatees, and sea turtles), and improve water quality (Sargent et al., 1995; p 1).

Thus, seagrasses are a principle contributor to the marine food chain, which is considered to be one of the most important sources of sea food for humankind (Thayer et al., 1975). Seagrasses also contribute to water quality and clarity by "stabilizing mobile sediments and by incorporating some pollutants into plant

biomass and into the stabilized sediments" (Sargent et al., 1995; p1).

The presence of propellor scarring on seagrass was noted in the scientific literature as early as the late 1950s (Woodburn et al., 1957; Phillips, 1960). However, it was not until the mid 1970s that the cumulative effects of prop-scarring and prop-dredging on seagrass meadows became a concern to marine ecologists (Zieman, 1976). Increased boating activities have had direct and indirect impacts on shallow-water seagrass beds. Scaring due to propeller damage (Zeiman, 1976; Folit and Morris, 1992) and increased turbidity from boat wake (Roat et al., 1993) effectively reduce the extent of seagrass beds by gouging out healthy grass and inhibiting new grass from rooting. The destruction of seagrass beds resulting from canal dredging to create and maintain navigable waterways represents an indirect boating impact on the bay environment (Box, 1997). Spoil from this dredging is commonly used to create fill for new housing developments. The biological effect of a dredged canal can be likened to the construction of a highway through a forest. Dredging has converted many shallow-water, biologically diverse seagrass beds into sterile channels used solely for boat navigation and access to private docks (Milleman, 1990).

A recent survey of the extent and intensity of seagrass-bed scarring was conducted by FMRI as part of an effort to develop a marine GIS database for the entire state of Florida (Sargent et al., 1995). The FMRI conducted an aerial survey to locate and map seagrass damage, as the effects of prop scarring, or

what the year-round shore residents refer to as "Yankee Tracks," are easily recognizable on normal-color aerial photography (Barker and Garrett, 1992; Sargent et al., 1995). Seagrass scarring is depicted on aerial photography as distinct areas of light colored lines and patches which contrast with the darker colored areas indicative of healthy seagrass meadows. This allowed seagrass beds to be interpreted, and digitized from aerial photographs. In addition, seagrass areas were categorized by the FMRI as being severely, moderately, or lightly scarred based on the "Comparison Chart for Visual Estimation of Percentage Composition" (Terry and Chilingar, 1955 in Sargent et al., 1995: p 9). For example, "polygons designated as light [encompassed] areas where less than 5 percent of the seagrasses were scarred, moderate polygons contained areas with from 5 percent to 20 percent scarring and severe polygons delineated areas with more than 20 percent scarring" (Sargent et al., 1995).

The formatting of the digitized information as a GIS database allowed FMRI to produce tables displaying acreage counts of slight, medium and severely scarred seagrass beds for each coastal county. For example, according to the FMRI study, Sarasota and Manatee counties[3] contain 16,320 acres of seagrass of which 3,320 acres (20 percent), are considered to be moderately or severely scarred.

Reduction in the area of seagrass beds in Sarasota Bay can be attributed

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[3]The three test sites for this study - Longbeach, Otter Key and Island Park - are located within the political jurisdictions of Sarasota and Manatee counties.

to canal dredging and the filing of other shallow seagrass areas for residential developments, such as Bird Key. Canal dredging and filling have segmented former continuous seagrass beds and increased boat access to other sensitive shallow water areas.

A recent study by Folit and Morris (1992) involved the implementation and evaluation of a program to protect selected seagrass beds in Sarasota Bay from motorboat propeller damage. Three test sites (all of which are adjacent to the selected anchorages in this study) were selected and marked with buoys, delineating the edges of seagrass beds and adjacent channels. A boater education program involving slide-show presentations and the distribution of brochures at popular nearby public boat ramps and marinas was implemented concurrently. Aerial photographs of the seagrass beds were taken to record the number and location of prop scars several months before and after the programs implementation. In addition, on-site monitoring of boating activities near two of the seagrass meadows recorded boater behavior before and after buoy placement.

The results of the study indicate that the clear identification of traffic channels near beds was effective in reducing the "accidental grazing" of seagrasses by "more naive and unfamiliar boaters" (Folit and Morris, 1992; p 36). However, seagrass bed marking had the opposite effect of attracting large numbers of more experienced boaters and fishermen to the seagrass meadows.

As such, Folit and Morris concluded that the placement of buoys:

> clearly brings more boats onto the grass beds and significantly increases recreational fishing on the grass bed. There was no evidence that the buoys led to more careful boating behavior over the grass beds such as tilting the motor up or using trolling motors or poles over the grass (Folit and Morris, 1992; p38).

The Folit and Morris study suggests that the clear demarcation of seagrass beds may not be an entirely effective management strategy. Increased boater education, general depth based restriction zones and fishing buffers are offered as recommendations to reduce propellor scars. In addition, they suggest that channels near seagrass beds be clearly marked with conventional channel markers, not seagrass informational markers (Folit and Morris, 1992).

The management strategies to reduce scarring suggested by Folit and Morris are congruent with those implemented in the Cockroach Bay Aquatic Preserve and Fort DeSoto Park, Pinellas County (Sargent et al., 1995). These plans incorporated a four-point approach which included increased boater education, better channel marking, limiting power boat access to more sensitive areas and more effectively enforcing existing laws. Despite these steps, however, " initial reports of their effectiveness are in some respects disappointing" (Sargent et al., 1995; p 33). A progress report by Dawes et al. (1994) confirmed that scarring had increased by an additional 5,000 linear feet. In addition, 145,000 square feet of additional scarring was reported near the entrance of the Aquatic Preserve (Dawes et al., 1994). The most effective

approach in reducing seagrass scarring, to date, has been the subsequent implementation of motorized boat-restriction zones in the Cockroach Bay Aquatic Preserve (Sargent et al., 1995).

Shorefront Resident and Boater Conflicts

Boating policy recommendations should not be made in a vacuum. Shorefront resident needs and desires are a valuable compass to guide policy decisions. Creighton (1983), Carp (1986), and Vining and Schroeder (1989) all maintain the necessity of evaluating public opinion and perceptions as an important factor in determining resource management priorities. Land-based community groups which include shorefront residents "define [anchorage conflicts] as a political issue" Antonini et al., 1990; p 73). The opinions of boaters are also an important factor in this equation. However, boaters are mobile, and thus are able to react immediately and directly to both their activity preferences, and to positive and negative outside elements, which may impinge on their boating experience (Lentnek, et al., 1969; Drogin, 1991; Box, 1997).

Many popular recreational anchorage sites are situated adjacent to upscale single-family and multi-family shorefront residential neighborhoods. The dramatic increase in boating activities in populated areas has led to conflicts with shorefront residents over noise, wake, trespassing, theft, trash, and loss of privacy (Antonini, et al., 1993; Antonini, et al., 1994). More specifically, shore residents identify jet skis and power boats as primary sources of noise and

annoyance (Antonini et al., 1994). Shore residents claim that jet skis not only adversely impact wildlife but are public safety hazards. The following quote reflects shore residents attitudes towards jet ski operators. "Not only are birds in danger by jet skis but so are people...It is no longer safe to swim in the waters of one's waterfront home" (Cuthbert and Suman, 1995: p135).

Ashton's (1971) lake carrying capacity study included a user tolerance index based upon a survey of shore residents to determine the degree to which their recreational use of the lake was affected by public boating activities. The results of the shore resident survey indicated that "riparian owners seem to be more sensitive to boating conditions and believe that they have more vested rights to the water body than public access boaters" (Ashton, 1971; p106). This early study, according to Dr. Niels West, University of Rhode Island, foreshadows the current perception that shore residents show little tolerance towards recreational boating activities occurring close to their property[4].

More recent studies of shore resident attitudes towards boat live-aboards by Antonini, et al., (1990) and Sesto, (1992) support Ashton's observation. Shore residents living near anchorage live-aboards assigned a higher degree of severity to the problems [associated with their presence] than those that did not".

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[4]The Bay Isles community, of Longboat Key, is currently appealing a court ruling that directed them to remove a "No Trespassing" sign posted at the mouth of a canal leading to their development. According to Tom Ankerson, Center for Governmental Responsibility, University of Florida, the court ruling in *Kaiser Aetna v United States,* 444 U.S. 164 (1979) suggests a legal precedent for the exclusion of boating activities within man-made water bodies.

(Sesto, 1992; p 110). The majority of shore residents surveyed by Sesto attributed declining water quality to the perceived dumping of sewage and waste to be the most serious problem connected to the presence of live-aboards. Sesto's findings verified the results of an earlier survey of marina managers, local business owners, and shore residents conducted by Antonini et al., (1990), concerning the perceived live-aboard responsibility for problems including sewage, garbage and floating debris.

The shore resident perception that the near shore water is an extension of their back yard runs counter to navigational servitude rights contained within the Commerce Clause of the U.S. Constitution. Navigational Servitude has "historically been used to ensure the right of the public to free and unimpeded navigation on the navigable waters of the United States" (Ditton, et. al., 1977). Navigational servitude, however, has recently come up against equally long standing American land-oriented traditions concerning the maintenance of property rights, land values, and the perception of the single-family neighborhood as being the superior living arrangement. These values lie at the foundation of American land use planning philosophy, which is to promote land values and the sanctity of the single-family neighborhood through the segregation of incompatible land uses (Garreau, 1991). Land-use zoning classifications have been greatly expanded over the years, but the basic philosophy and objectives remain unchanged regarding the protection of the single-family neighborhood from outside intrusion. This philosophy is echoed in

United States Supreme Court Justice Douglas' statement in *Belle Terre v Borass*, 94 s.ct 1536, (1974), that the protection of "family values, clean air, and quiet seclusion are legitimate community goals" (Mandleker, 1985; p209). Thus, conflicts between shore residents and boaters have resulted in the collision between two deeply-rooted land and water-oriented legal traditions which are both aimed at protecting basic yet contradictory public rights - the right to access and the right of privacy.

To conclude, water-surface zoning is predicated on reducing social and environmental conflict. The literature clearly shows the impact which boating activities have had on marine mammals and shallow water seagrass beds. There is also mounting evidence to show that increasing on-water activities create tension between shore resident populations and boaters. Zoning is considered to be an effective mechanism to reduce social conflict and environmental impact in an urban context, but its direct application to the water has been limited. Previous research has applied user defined zones to boat activity relationships in a lake settings. There is limited research to date involving a site-specific, map-based analysis incorporating social and bio-physical parameters to define net useable activity spaces in a coastal environment. However, past research and current applications of water surface zoning illustrate the potential of this regulatory strategy to promote environmental awareness and alleviate conflict.

CHAPTER 3
METHODOLOGY

The review of the literature suggests the need for a comprehensive, place-based approach to anchorage management. The following methodology details a comprehensive approach to the development of water-use zones for this purpose. As such, the strategy integrates bio-physical and social criteria by utilizing geographic-information-systems (GIS) and global-positioning-systems (GPS) mapping technologies for the collection, management, analysis, and display of data.

The water-use zoning strategy presented adheres to the principles of the hierarchical approach to GIS reasoning offered by Thrall (1995; Thrall and Wofford, 1997; Thrall, 1999). According to Thrall, GIS analysis should support elements of six "analytical" stages: description, explanation, prediction, judgement, implementation, and management and monitoring. Thrall maintains that GIS applications should involve a "blending from one stage to another, along with a shifting back and forth between earlier and later stages" (Thrall 1995; p 50).

The methodology described in this chapter satisfies the elements of Thrall's six-staged process of GIS reasoning. Thrall's operative stages are

satisfied by the following research components: (1) An inventory of bio-physical, recreational boating, and social components which comprise the anchorage site geography; (2) The solicitation of shore resident attitudes and feelings towards boating activities along with their demographic profiles; (3) The use of a statistical model to predict the "specific "numeric magnitude of change" (Thrall 1995; p 48) of shore residents' tolerance over distance, for specific boating activities; (4) The monitoring of observed boating activities to define the frequency and spatial extent of site-related boating impacts, and (5) Map output that designates zones where specific boating activities may or may not be appropriate. Map products integrate and synthesize spatial data and statistical output allowing planners, resource managers, and boaters to visualize results and make management and recreational decisions on the basis of the zoning strategy.

A comprehensive description of the data collection and analytical techniques is presented in this chapter. The first section provides a description of the process and explains the rationale for selecting the sample sites. This is followed by an overview of the methodological components or research aims. Subsequent sections are devoted to the assumptions and methodology developed to satisfy each of the five specific research aims.

Selecting Study Sites

Local boating experts who are members of the Boaters Action and Information League (BAIL) identified 47 anchorages in Southwest Florida that are commonly used both by residents and transient vacationers for storm refuge, recreation, and as locales for experiencing nature. As such, these anchorages are considered to be popular recreational sites and cruising destinations. These anchorage sites offer a variety of environmental conditions and boating facilities which affect the intensity and frequency of their use. Some anchorages have been subjected to increasing user pressure because of their natural attractiveness, sheltered location, proximity to boating facilities or land-side attractions.

A charette[4] was conducted in which a focus group of experts in marine related fields identified and ranked management issues in order of importance for the 47 popular Southwest Florida anchorage sites. Management issues included both habitat and non-habitat related descriptors. The focus group used these management issues to develop a general typology (urban, suburban, rural) for the 47 Southwest Florida anchorages. In addition, management issues were used to rank each site according to its need for pro-active or passive (non-regulatory) management. Of the 47 sites, 13 were identified as having pro-active management needs (Antonini et al., 1998). The three test sites were

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[5]Applications of charettes to identify and rank environmental criteria can be found in Thrall and McCartney (1991) and Thrall, Swanson and Nozzi (1988).

chosen from among those 13.

Site Description

Otter Key, Longbeach, and Sarasota Island Park represent three popular anchorage sites in Sarasota and Manatee Counties. The three test sites are considered to be representative examples of urban and suburban anchorages along the Southwestern Florida coast that have sensitive shore resident populations, presence of seagrass, recognized crowding problems, different shoreline land use configurations and varying amounts of adjacent natural shorefront. The proximate location of the sample sites in Sarasota and Manatee Counties also facilitates long-term monitoring.

The Otter Key site is roughly 30 acres - four of which contain "lightly scarred" seagrass beds according to Sargent et al. (1995). The anchorage is located adjacent to an upscale single-family residential neighborhood near St. Armand's Key. A previous survey of shorefront residents there suggests that they are sensitive towards on-water activities (Antonini et al., 1994). A large undeveloped island, presence of seagrass, and proximity to Big Sarasota Pass and upscale shopping make the Otter Key anchorage popular among boaters. This is reflected in Otter Keys management need rank of 7th out of the 47 sites (Antonini et al., 1998).

The Longbeach anchorage, located on Longbeat Key approximately 9 miles north of Otter Key in Manatee County, offers land use contrasts to the

Otter Key site. The Longbeach site is approximately 45 acres in area, and is comprised of a greater variety of shorefront land-uses including residential single-family, commercial (restaurants), and a public boat ramp. This site's location adjacent to the Gulf Intracoastal Waterway also makes it accessible to a greater variety and frequency of boating activities. Jewfish Key, a private island with mangrove and Australian pine, boarders the site on the east. The anchorage contains 19 acres of seagrass beds categorized as "non-scarred" by Sargent et al. (1995). This non-scarred status makes Longbeach a good candidate for long-term boat monitoring with the objective of preserving its relatively pristine seagrass beds. High resolution color aerial photography indicates the presence of some seagrass scarring. Longbeach is ranked 6^{th,} by Antonini et al., (1998), out of the 47 sites with respect to management needs.

Island Park is one of the largest, most active, anchorages in Southwest Florida. It is ranked fourth by Antonini et al. (1998) with respect to pro-active management needs. Island Park is a prime example of a high intensity water-use site. The anchorage is roughly 100 acres in area, with the northeastern portion consisting of nearly 12 acres of seagrass beds fringing the shoreline and several uninhabited mangrove islands. During the boating season (January through April) over 100 boats are moored long-term and overnight. There is also a visible live-aboard population. In addition, jet ski and boat charter rentals operate from waterfront businesses at the anchorage and nearby locations. A large municipal marina, located adjacent to the anchorage, is an additional

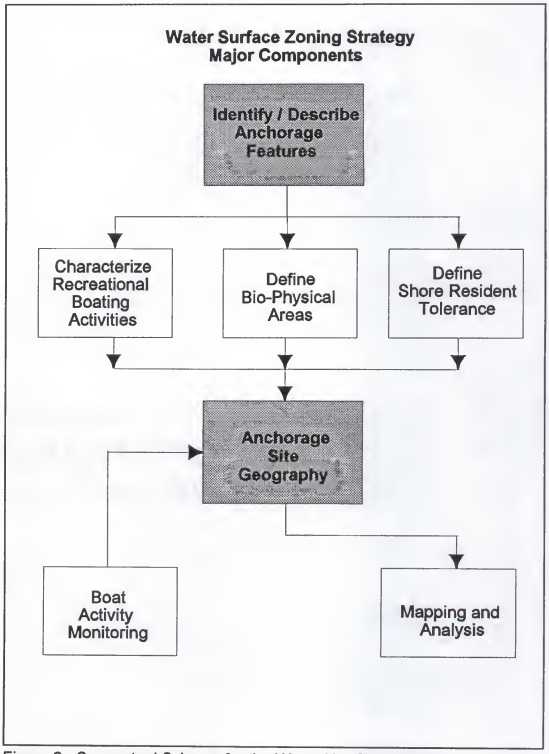


Figure 2. Conceptual Scheme for the Water-Use Zoning Strategy.

source of boating activities and traffic through already congested waters. Other adjacent land uses include a public waterfront park, high-rise residential condominiums, and commercial uses including restaurants, hotels, and banks. Several upscale neighborhoods also share the nearby waterfront.

The Island Park anchorage has been the focus of numerous complaints over live-aboards, derelict vessels, stored (unattended) boats, boat crowding, and trash, according to Antonini et al. (1998). Consequently, the Island Park anchorage possesses many of the traits that identify sites in need of more pro-active management.

Methodological Components

The methodology presented consists of five components (Figure 2): (1) characterizing recreational boating activities; (2) defining bio-physical areas; (3) defining shore resident tolerance; (4) mapping and analysis; and (5) monitoring boating activities. The first three components involve the identification and description of anchorage site characteristics. This includes an inventory of bio-physical features, and surveys of shore residents, and recreational boating activities. On-site monitoring, utilizing a GPS and laser range-finder, provides information on the location, frequency, and spatial extent of specific recreational boating activities. A GPS survey of water depth, bottom type, and seagrass bed areas define homogeneous bio-physical zones which comprise the "environmental" component. A survey assessing shore front residents' attitudes

towards on-water boating activities is the social component.

Shore resident and GPS-based bio-physical surveys provide the basis for the development of GIS spatial databases. These databases represent important bio-physical, and social components of the anchorage site geography. These features define the net useable space available at a site for recreational boating activities. The fourth component of the strategy involves the combining and manipulation of the spatial databases within the GIS for the development of stress surfaces for specific recreational activities. Individual stress surfaces identify water-use zones within the anchorage site that are most suitable for that particular boating activity.

A survey of recreational boating activities from waterfront locations using a laser range-finder and GPS equipment satisfies the fifth research component. It allows for the verification of shore resident tolerance buffers and water-use zones. The following sections detail the methodology developed to satisfy the five main components of the water-use zoning strategy.

Characterizing Recreational Boating Activities

The planning for and management of recreational boating activities requires knowledge of which boating activities are most common and potentially problematic. Therefore, identifying the recreational boating activities that are common to the study areas is an important initial component of an inventory and description of the anchorage site geography (Figure 3).

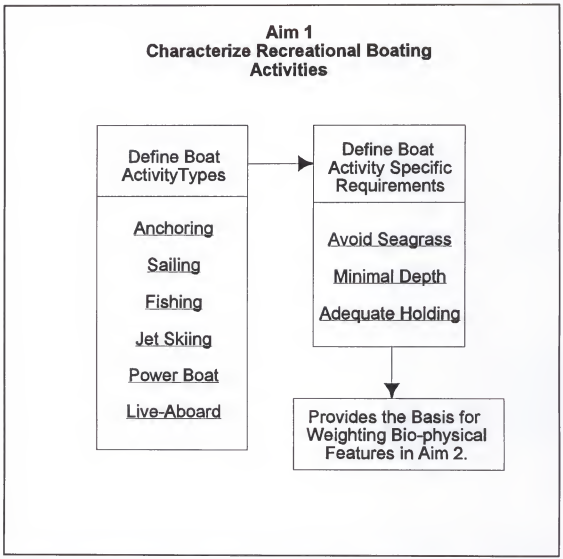


Figure 3. Characterizing Recreational Boating Activities.

The activities selected for this research represent a comprehensive list of recreational boating activities common to the study areas. Recent boat surveys of Sarasota Bay conducted by Antonini et al., (1994) and Antonini and Box (1996), identified over-night and live-aboard anchoring, sailing, power boating, jet skiing, and fishing as primary recreational boating activities in the area.

Many of the chosen boating activities also were identified by shore residents as being responsible for anchorage site issues, such as noise, wake, floating debris, trespassing and theft. (Antonini et al., 1994).

Identification of the specific activities to be studied allows for the determination of which physical features are necessary to inventory. Definitions of these activity specific requirements are based on those selected by Antonini et al, (1994) and include:

1. Minimal water depth for draft
2. Avoid seagrass beds
3. Adequate bottom-holding for anchoring

Bio-physical characteristics are selected, and net useable space is determined on the basis of these pre-defined activity specific requirements.

Recent surveys of Sarasota Bay boats conducted by Antonini et al. (1994), Antonini and Box (1996), and Antonini et al., (1998) identified the modal boat length range to be between 16 and 25 feet and the average draft of recreational power and sail boats to be roughly three and four feet, respectively. These estimates of boat length and draft guided the choice of grid cell dimensions used in the GIS analysis, the selection of depth breakpoints, and factored into the relative weighting of the bio-physical components.

Defining Bio-Physical Areas

Spatial Database Development

The second aim of the research involves the development of a set of criteria delineating homogeneous bio-physical zones for specific boating activities occurring within an anchorage site. This is accomplished by the selection, inventory, and development of spatial databases for the important bio-physical descriptors (Figure 4).

Bio-physical site descriptors include bathymetry, bottom type, seagrass beds, and the existing shore line geometry. These characteristics were chosen to represent important criteria for anchoring and navigation, according to a survey of area boaters (Antonini, et al. 1994). The bio-physical site characteristics were field mapped by boat using a GPS receiver, data logger, depth sounder, and divers. Each site was buoyed and transected. The buoys were placed approximately 100 feet apart for the length of the site. Buoy-defined transects provided clear paths for navigation resulting in the consistent spatial coverage of selected bio-physical features.

Bathymetric readings were recorded every few feet along each transect by a computerized datalogger connected to a GPS, with the aid of a depth sounder (a lead line was used in shallow areas). Each depth reading was recorded as an individual point. For each site, an observer was stationed at a nearby benchmark to record the water elevation at 15 minute intervals concurrent with the logging of bathymetric data. This ensured that bathymetric

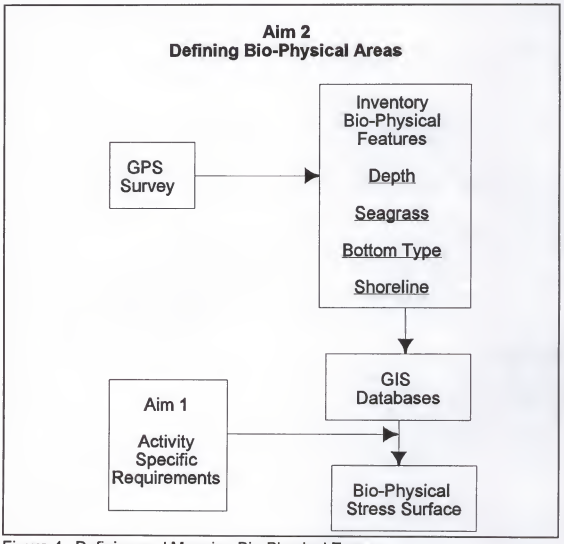


Figure 4. Defining and Mapping Bio-Physical Zones

readings could be adjusted to the mean lower low water navigational datum.

Bottom characteristics including, soft and hard silt mud, sand, rock, shell, and coral, also were recorded as a series of points using a GPS and data logger. The collection of bottom type information required the help of a biologist /diver who relayed bottom information "topside" via a special electronic headset. It was the helmsman's job to ensure that the boat and GPS was located as close

as possible to the underwater position of the diver. The divers underwater position was almost always visible due to the relatively shallow depths at the anchorages and good water clarity.

Seagrass areas were mapped in a similar fashion with divers relaying the presence or absence of seagrass at specific locations along each transect. Once a rough boundary was identified the divers concentrated their efforts along this edge, in order to define the seagrass area more precisely.

Bio-physical GPS data subsequently were converted to spatial databases as point coverages utilizing the Arc/Info GIS software. Bottom type, seagrass, and bathymetric point coverages were converted to polygon or area coverages through a digitization process that "connected the dots". Bathymetric data were collapsed into three foot depth ranges prior to being digitized as polygons.

Anchorage site boundaries and the shore line were determined on the basis of photographs and site maps contained in "A Guide to Anchorages in Southwest Florida", published by the Boaters Action and Information League (BAIL, 1994). Shoreline and on-water boundaries for each site were digitized using the Arc/Info GIS software from large-scale (1:2400) black-and-white aerial photographs obtained from the Florida Department of Transportation. The digitized shoreline and site boundaries were transformed into real-world coordinates using control points collected on site with the GPS. Control point locations included readily identifiable features on the aerial photographs, such as road intersections, seawall corners, and dock corners.

Bio-Physical Scoring Scheme

Bio-physical descriptor scores require the development of a scoring system based on a ranking of the bio-physical features and a comparison of bio-physical features with respect to boating activity specific requirements. For example, each bio-physical area (seagrass, depth, bottom type) is ranked in order of importance and described as meeting or falling below boating activity requirements. Areas meeting the activity requirements are assigned lower values for lower stress, and areas failing to meet requirements are assigned larger values for greater stress. Upon combining the spatial databases, this scoring scheme provides the variable weighting necessary for the creation of a GIS bio-physical stress surface (Table 1). A similar GIS overlay approach was taken by McCarthy (1991) to rank and select lands, on the basis of environmental parameters, for public acquisition.

Table 1. Bio-Physical Weighting Scores.

Scoring Scheme for Bio-Physical Features		
Variable	Score	
	Yes	No
*Depth less than 5 feet **Depth less than 3 feet	2	1
Seagrass present	3	1
Bottom type favorable	1	2

* Applies to the activities of anchoring, sailing and live-aboards.
**Applies to the activities of jet skiing, fishing, and power boating.

Defining Shore Resident Tolerance

The views of shore residents who live adjacent to these popular urban and suburban anchorages are an important component of this place-based methodology. Shore residents' "scenic views, security, general enjoyment of the locale, and sometimes their level of business activity, are affected by the appearance, activity, and density of anchored boats [and other boating activities] in the immediate vicinity" (Antonini et al., 1994; p 87). According to Antonini et al., "shore residents and commercial property owners facing anchorage areas are key players, competing (and sometimes conflicting) with boaters over waterfront and anchorage uses" (Antonini et al., 1994; p55). Thus, shore residents are directly impacted by nearby on-water recreational activities, and therefore, their opinions must be considered as part of the planning and management process.

Shore resident attitudes are incorporated into the water-use zoning strategy through the development of a methodology (Figure 5) that delineates social tolerance zones for specific boating activities. This third research aim is accomplished by quantifying shore resident attitudes towards boating activities by estimating attitudinal tolerance on the basis of location, distance and activity type. Toward this end, an opinion survey elicited the attitudes of shore residents responses from shore residents at the three test sites, towards recreational boating activities near their property.

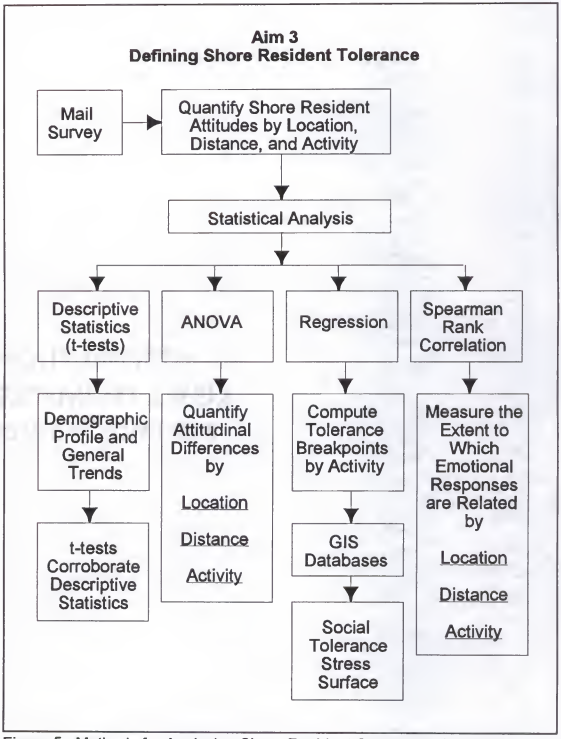


Figure 5. Methods for Analyzing Shore Resident Surveys and Defining Social Stress Zones

Survey Goals

The shore resident survey had the following specific goals:

Goal One. Define distance breakpoints at which shore residents at each site become "intolerant" or "indifferent" towards specified recreational boating activities.

Goal Two. Describe shore resident attitudes towards specified recreational boating activities with respect to activity, distance, and location

Goal Three. Determine whether residents' emotional responses to boat recreation are correlated with their location, the type of activity, and the distance at which the activity occurs.

Specific Objectives

Survey goals are satisfied through descriptive and statistical analyses focused on the following specific objectives:

Objective One. Focus on activity: Determine if a significant difference exists in the way shore residents emotionally respond to particular activities, irrespective of location and distance.

Objective Two. Focus on distance: Determine if a significant difference exists in the way distance affects shore residents' emotional responses towards boating activities.

Objective Three. Focus on location: Determine if a significant difference exists in the way residents at each particular site emotionally respond to

specific activities irrespective of distance and, if there is a significant difference in the way residents at each particular site emotionally respond to distance, irrespective of activity.

Objective Four. Focus on activity and distance: Determine if the interaction between activity and distance is significant.

Objective Five. Focus on distance and location: Determine if the interaction between distance and location is significant.

Objective Six. Focus on activity and location: Determine if the interaction between activity and location is significant.

Objective Seven. Focus on activity, distance, and location: Determine if the interaction between activity, distance, and location is significant.

Objective Eight. Determine distance, activity. and location are correlated with residents' emotional responses.

Questionnaire Development

Each questionnaire included an aerial photograph specific to each of the three test sites. Distances of 200, 400, 600, and 800 feet from the shoreline were plotted on the aerial photographs. Shore residents were asked to evaluate the degree to which specific boating activities occurring, at each distance annoyed them, excited them, and gave them a feeling of helplessness. Responses ranged from +3 (pleased, excited, in control) to -3 (annoyed, calm, helpless). Background information included questions regarding, age, gender, education, income, boat ownership, dock ownership, and period of residence.

The questionnaire and related correspondence is provided in Appendix A.

Questionnaires were modeled after a survey technique developed by Mehrabian (1980). Mehrabian identified three dimensions (pleasure, arousal, and dominance) which "constitute a parsimonious description of the common core of human emotional responses to all situations" (Mehrabian, 1980; p14). According to Mehrabian, pleasure and displeasure is expressed through "general positive versus negative facial expressions". Positive behavioral indicators include smiles, laughter; negative expressions include frowns. Arousal refers to a combination of activity and alertness. Dominance is described as "the extent to which [an individual] feels unrestricted or free to act in a variety of ways" (Mehrabian, 1980; p18). The concept of freedom, according to Proshansky et al. (1970) is related to privacy, territoriality, and crowding. When privacy and territory are compromised, freedom of choice becomes limited. This, in turn, reduces ones control over his immediate environment. These findings are corroborated by Edney (1976) who maintains that territories are connected with a personal sense of security, control and self-determination" (Edney, 1976; p811). A variant of Mehrabian's three-dimensional, emotion-based theory was implemented through the use of the adjectival pair descriptors pleased / annoyed; excited / calm; and helpless / in control.

Survey Implementation

An opinion survey was carried out at each of the three test sites. The

survey was conducted in the following manner: (1) waterfront parcels were identified through air photo interpretation; (2) selected parcels were matched against property appraiser plat parcel maps and records to identify each shore resident's name and address.

Each resident, identified as living adjacent to one of the three test anchorages, was either hand-delivered or mailed a questionnaire. Island Park condominium managers distributed and collected completed surveys from residents whose condominiums faced the anchorage site. Numbered surveys were hand-delivered to Longbeach and Otter Key residents. A second contact was made with non-respondents whose telephone number was identifiable. If requested, a second survey was mailed. An additional questionnaire and cover letter was also mailed to those residents who did not respond within two weeks and who could not be reached by phone.

The shore resident population, 214 individuals at the three sites, was inventoried and contacted; 85 people responded providing a 40 percent overall response rate (Table 2). The survey return breakdown indicates a much higher response for Otter Key and Longbeach sites than Island Park. Island Park condominium return rates varied from a low of 18 percent at the Regency House to a high of 86 percent at Versailles.

Statistical Analysis

The statistical analysis of shore resident survey data is divided into four components. First, the raw data are averaged and graphed as part of a

descriptive analysis illustrating general emotional response trends on the basis of activity, distance and location. Background demographic information is treated in a similar fashion, providing a characterization of the sample population.

Second, a multi-way analysis of variance (ANOVA) model is used to determine whether or not significant differences in pleasure or annoyance exist on the basis of location, distance, and activity. Included in the ANOVA model

Table 2. Survey Return Breakdown.

Shore Resident Survey Return Rate			
Island Park	total homes	total response	percent return
Regency House	40	7	18
Embassy House	69	17	25
Essex House	35	23	66
Royal St. Andrew	26	10	38
Versailles	7	6	86
Otter Key	22	13	60
Longbeach	15	9	60
total returned	214	85	40

are the following random and fixed effects[6]. Random effects include:

[6] Fixed effects refer to specific comparisons among variables with pre-defined levels such as activity, location, and distance. Random effects refer to variation in individual preference among respondents.

Ind_ID (site)	Measure variation among respondents' scores within the same site
Fixed effects include:	
Site	test effects of location on activity and distance
Activity	test effects of specific activities between sites
Distance (site)	test effects of specific distances within each site
Site * Activity	test interaction of specific activities between sites
Activity * Distance (site)	test interaction of specific activities with each distance within each site

The ANOVA model first tests for variation in emotional responses among individual respondents (random effect). The model first calculates the amount of error that can be attributed to individual variation alone. Fixed effects then are tested in comparison to the residual model error. A first run of the model establishes significant and non-significant fixed effect interactions, for the pleasure variable alone, as based upon a p value of $< .05$. Non-significant effects are then eliminated, and the model is run again. The final results represent all significant interactions from the reduced model.

A simplified ANOVA model which does not consider individual variation is used to compare significant effects and interactions for each of the three emotional variables (pleasure, arousal, and control) independently. A simplified

version of the original ANOVA model was required due to missing data for the arousal and control variables. Missing data were the result of incomplete responses by survey respondents.

Third, upon demonstrating that distance has a significant effect on tolerance, least square means generated from the interaction of activity*distance(site), for the pleasure variable alone, are used in a regression model to identify distance breakpoints at which specific activities become socially tolerable. This is accomplished by replacing distance effects with continuous variables for X using 200, 400, 600, and 800. Thus, for the regression line

$$Y = a+bX,$$

Y = 0 at the distance (X) at which attitudes towards activities become indifferent. Hence,

$$X = -a/b$$

Dividing the intercept (a) by the slope (b) provides the distance breakpoint at which emotional response towards a specific activity become indifferent. In addition, least square means for the interaction of Activity * Site_ID (Site) generated by the ANOVA provide a basis for comparing inter- and intra-site emotional responses with respect to each activity.

The emotional variable, pleasure, is used in a more complex ANOVA model to satisfy the first seven objectives. The simplified ANOVA model, run independently for pleasure, arousal, and control is used to determine if each

emotional variable contributes significantly to attitudinal differences on the basis of location, activity, and distance.

The fourth component of the statistical analysis determines the extent to which responses for each of the three emotional variables (pleasure, arousal, control) are related (objective eight). For example, does a high degree of annoyance for jet skiing at 200 feet correspond to low or high feelings of control, low or high feelings of arousal? A Spearman rank correlation statistic (rho) is used to measure the extent to which pleasure, arousal, and control responses are correlated on the basis of activity, distance, and location. Spearman's rho , is an ordinal measure of association between variables, based on rank. The statistic is calculated by ranking observations, and squaring the differences in rank between them. Ties in rankings are resolved by averaging the rank over the number of affected observations. Squares are summed over all the variables, and standardized so that results are between -1 and 1. Spearman's rho statistic provides a measure of strength of association between variables. A rho value approximating -1 or 1, indicates that a positive or negative relationship exists between the two variables. A value approximating 0 suggests a lack of correlation.

The Mehrabian (1980) study concludes that each of the three emotional dimensions (pleasure, arousal, and control) are independent. A low correlation between the variables would support Mehrabian's theory of independence. Conversely, a high degree of either positive or negative correlation would

suggest some degree of dependence existing between emotional variables.

Social Tolerance Scoring Scheme

A social tolerance scoring scheme provides the variable weighting necessary for the creation of a GIS social stress surface, as was done for each bio-physical variable. Areas failing to meet social tolerance standards are assigned a weight of 3. Areas meeting social tolerance standards are assigned a weight of 1. Variable weighting is consistent with the outcome of a delphi survey of marine experts who ranked environmental and social concerns as the most important criteria in determining anchorage management needs (Antonini et al., 1998).

GIS Analysis and Mapping

A Trimble Navigation ProXR GPS with radio beacon, a TDC 2 data-logger, and an Atlanta Laser, laser range-finder, was used in the field research. Digital database development, analysis, and mapping was completed using the Arc/Info 7.1 and ArcView 3.0a GIS software.

Database Development

The fourth research aim integrates bio-physical areas and social tolerance zones within the GIS, to delineate high, medium, and low stress boating activity water-use zones (Figure 6). A digital base map, illustrating the shoreline, property boundaries and water-side anchorage boundaries, was developed for each site. This task was accomplished through a process of air

Aim 4
Mapping and Analysis

DATABASE DEVELOPMENT

- Shoreline digitized from aerial photographs
- GPS control points used to transform shoreline data to real-world coordinate system
- Bio-physical GPS data converted to GIS point features
- Pio-physical point data converted to GIS polygon features
- Social tolerance zones generated by buffering the shoreline by the distance calculated by the regression of ANOVA LSMEAN's against distance
- Convert all databases to GIS grid format

ANALYSIS

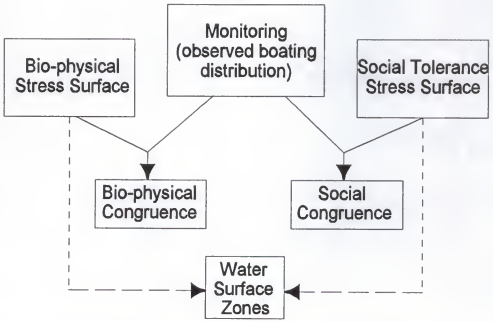


Figure 6. GIS Methods for Mapping and Validating Water-Use Zones.

photo interpretation and digitization from large-scale aerial photographs. GPS positions taken on-site and identifiable on the large-scale aerial photographs provide the basis for the transformation of the digital base map to a real-world coordinate system.

Bio-physical GPS point data are converted to an Arc/Info point coverage format using utilities provided by the Trimble GPS software. The point data associated with each bio-physical site characteristic are converted to polygons through a process of identifying and digitizing boundaries around point ranges by "connecting the dots". For example, boundaries are digitized for each depth range (0 to 3 feet, and greater than 3 feet for power boating, jet skiing, and fishing; 0 to 5 feet, and greater than 5 feet for sailing, anchoring and live-aboards), and bottom type (silt mud hard; silt mud soft; rock, shell). Seagrass areas, defined and illustrated in the GIS as a series of point measurements, are converted to polygons by on-screen digitizing with a rectified color image of the area as a backdrop. The site shoreline and pre-defined anchorage boundary provide the extent for each bio-physical database. Each bio-physical data layer is converted to a grid and combined with the others. This process synthesizes bio-physical site elements as a single GIS stress surface. Higher stress is associated with areas (grid cells) having large composite scores, as defined by the weighting scores assigned to each variable.

Shore resident tolerance responses are converted to GIS databases by buffering the shoreline by the distance for each boating activity estimated from

the regression of the pleasure variable ANOVA LSMEAN's against distance. A distance isopleth defines the breakpoint between areas where an activity is and is not tolerated. In this manner, a tolerance data layer is developed for each boating activity. In instances where the predicted tolerance distances for an activity (such as jet skiing and live aboards) extended beyond the limits of the site, a tolerance weight of 3 (high social stress) was assigned to the entire site.

GIS Analysis

Each data layer comprising social, and bio-physical site features is converted to a grid and combined. In this way, the weights assigned to each variable accumulate spatially. The resulting digital layer divides the anchorage site into 5 foot grid cells, each cell containing a composite stress value relating to the number of incompatible social and bio-physical features present. The higher the number, the greater the incompatibility associated with a boating activity located in that area.

Bottom type is applicable only to overnight and live-aboard anchoring activities, which have a maximum achievable stress score of 10. This variable is not considered for other boating activities. Consequently, the maximum possible score for boating activities not requiring bottom type is 8. Compatibility ranges (low, medium, and high) for each activity are obtained by adding the weighted values of each variable and comparing the composite value with ranges. Stress range intervals are calculated by dividing the maximum score by three (Table 3).

Stress surfaces indicating appropriate and inappropriate water-use zones are developed for each specific activity on the basis of these ranges. Cells accruing low point scores (3 to 5) are considered the most appropriate locations for associated activities. Moderate compatibility is achieved in cells accruing medium point scores (5 and 6). Point scores in the high range (7 to 10) indicate areas that may be least appropriate for associated activities.

Monitoring Boating Activities

An important requirement of any planning endeavor involves feedback.

Table 3. Activity Suitability Scoring Ranges.

Activity Suitability Scoring Ranges			
Activity	Low Stress	Medium Stress	High Stress
Anchoring	4 and 5	6 and 7	8, 9 and 10
Sailing	3 and 4	5 and 6	7 and 8
Fishing	3 and 4	5 and 6	7 and 8
Power Boating	3 and 4	5 and 6	7 and 8
Live Aboard	4 and 5	6 and 7	8, 9, and 10
Jet Skiing	3 and 4	5 and 6	7 and 8

Monitoring provides such a feedback and represents the fifth aim of the water-use zoning strategy. The monitoring component (Figure 7) is fulfilled by describing the type, frequency of occurrence, and the spatial extent of selected recreational boating activities in each study site. The monitoring strategy

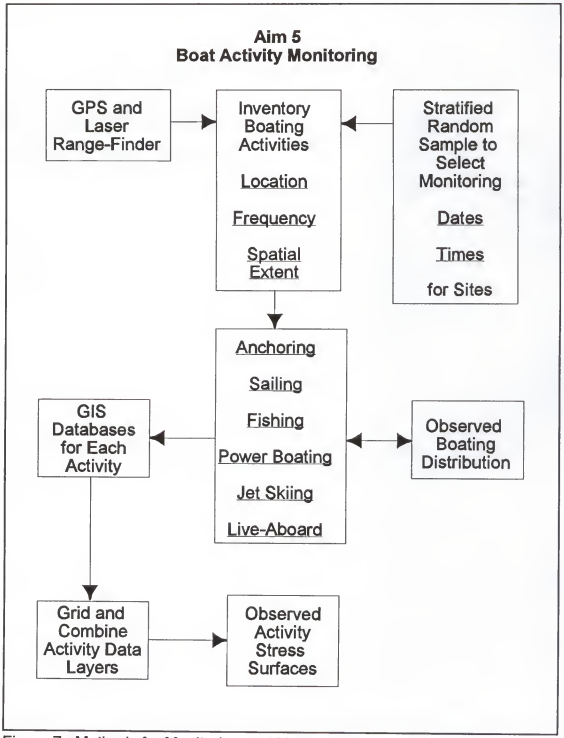


Figure 7. Methods for Monitoring and Mapping Observed Recreational Boating Activities.

developed for this research with contributions by Dr. Gustavo Antonini and Dr. Niels West, University of Rhode Island, is detailed in a memo to the Anchorage Pilot Project Technical Advisory Committee. This memo, entitled "Strategy for Monitoring and Evaluating On-the-Water Activities at Selected Anchorages" is included in Appendix B. Preliminary data for the four sample days in July, 1998 will be used to compare current utilization with proposed water-use zones. A full analysis of data generated by site monitoring is outside the scope of this dissertation. However, a discussion of the tasks necessary to incorporate and analyze monitored data follows.

An inventory of activities at the selected sites will be conducted for a period of one year, on pre-defined days, at pre-defined hours. A stratified random sample approach, developed by Professor Niels West (Appendix B), was used to select the days and times for on-site monitoring. Activity monitoring is accomplished using a GPS and laser range-finder. GPS data are then converted to an Arc/Info point format in the same manner as that described for the bio-physical data. A boat identification number is attached to each point representing the location of a specific boat along its travel route. This is accomplished through the use of a data dictionary programmed for use with the Trimble data logger. In this way, points comprising individual daily travel routes can be connected by arcs and converted to Arc/Info line coverages. Line coverages for each survey day subsequently are converted to grids of 25 foot cell sizes and combined using the Arc/Info GRID module.

Rather than considering the specific number of boats traveling through the site, the combined paths taken by the boats is felt to better reflect boating impact on the site. Accordingly, areas (grid cells) where multiple paths crossed for subsequent survey days receive higher stress scores. The highest score obtainable for any given grid cell is four - the number of July, 1998 survey days. Frequently traveled grid cells accumulate point values permitting the determination of the most heavily utilized areas for specific activities at each of the study sites. This output is then compared with data layers containing the most and least suitable areas for specific activities. This allows for the generation of a grid database distinguishing areas of particular vulnerability. A vulnerability index is intended to relate observed impacts from monitoring to water-use zones.

Vulnerability zones for each site are derived from the combination of water-use zones and activity frequency stress surfaces. The following methodology describes the steps required to generate vulnerability zones. Translation of these data layers into a vulnerability index is accomplished by using the RECLASS function within Arc/Info's GRID module. Water-use zone grids comprised of low, medium, and high stress value ranges (Table 3), are reclassified and displayed (Table 4) as 1, 2, and 3, respectively. For example, for anchoring, values of 4 or 5 are reclassified to 1; values of 6 or 7 are reclassified to 2; and values of 8 through 10 are reclassified to 3. Second, activity frequency grids are reclassified according to low, medium, and high point

accumulations, based on the number of survey days that each grid was impacted by travel paths. The greatest frequency point accumulation possible is four (the number of July survey days). Finally, both reclassified grids are combined, resulting in point accumulations and corresponding vulnerability ranges (Table 4). Vulnerability ranges are used to identify areas within the anchorage site that may be more vulnerable to increasing boating activities.

Table 4. Vulnerability Scores and Point Ranges.

Vulnerability Classification Scheme	
Vulnerability Point Scores	
Activity Frequency Stress Surface	Water-Use Zones
0 or 1day: Low Frequency	1 (Low Stress)
2 days: Medium Frequency	2 (Medium Stress)
3 or 4 days: High Frequency	3 (High Stress)
Vulnerability Point Ranges	
Low (1, 2, 3) point combinations	Low Frequency - Low Stress
	Medium Frequency - Low Stress
	Low Frequency - Medium Stress
Medium (4) point combinations	Low Frequency - High Stress
	Medium Frequency - Medium Stress
	High Frequency - Low Stress
High (5, 6) point combinations	Medium Frequency - High Stress
	High Frequency - High Stress
	High Frequency - Medium Stres

CHAPTER 4
SHORE RESIDENT SURVEY METHODS AND FINDINGS

This chapter presents quantitative methods and findings related to the analysis of the shore resident survey. A demographic profile of the shore residents is presented first. This is followed by a descriptive evaluation of shore resident emotional responses to the presence of selected boating activities. T-tests are used to verify general descriptive trends in emotional responses. Subsequent sections are devoted to describing complex emotional response patterns to boating activities, through an analysis of variance (ANOVA); quantifying shore resident tolerance for specific boating activities, using regression analysis; and quantifying relationships between emotional variables, using a Spearman rank correlation analysis.

Demographic Profile

Eighty-two percent of the shore residents responding to the survey were aged 60 years or older. Most were over age 70, and a very small percent were under age 50. Most (66 percent) were retired: Specifically, 70 percent of the Island Park sample and about 50 percent of the Longbeach and Otter Key respondents. An equivalent number of males and females responded. Seven

percent had children under the age of 18 living at home, and 27 percent responded that their grandchildren visited frequently.

Eighty-seven percent own their homes and 84 percent were year-round residents. A breakdown of the seasonal residence for the three sites is as follows: Island Park, 15 percent; Otter Key, 18 percent; and Longbeach, 80 percent.

Three quarters of Otter Key and Longbeach respondents own boats, while only 7 percent of Island Park residents indicated boat ownership. Of those people who own boats, 60 percent owned power boats, 23 percent owned non-motorized watercraft, and 17 percent own one of each type.

Over 60 percent of the shore residents surveyed had a college degree and an additional one-quarter had completed some college: Specifically, 67 percent of Longbeach respondents had completed a post-graduate or professional degree, as had 40 percent of Island Park respondents, and 15 percent of Otter Key respondents. The remainder had a high school or vocational school education.

Most individuals (50 percent) had an income of between $50,000 and $100,000, while 32 percent and 18 percent reported incomes of less than $50,000 and above $100,000, respectively.

Thus, the typical shore resident is retired, a year-round resident, college educated, over sixty years of age, with an income of between $50,000 and $100,000, and owns their shorefront home. In addition, Otter Key and

Longbeach residents typically own at least one boat or watercraft.

Identifying General Trends in Emotional Response to Boating Activities

Descriptive Analysis Methods

A descriptive evaluation of the survey data identifies general trends and associations between emotional and descriptive variables. Site responses averaged by activity and distance, for each emotional variable, are provided in Appendix C.

Averages of activity means for each site (Table 5; Figures 8, 9, and 10), allow for numeric and visual comparisons of the overall emotional intensity felt by respondents towards each activity, irrespective of distance.

Averages of activity means for each distance (Table 6; Figures 11, 12, and 13), allow for the comparison of the overall emotional intensity felt by respondents for each distance that an activity occurs, irrespective of site.

Grand means (means of distance and site averages by activity), illustrate the general relationship between each emotional variable with respect to activity (Table 7, Figure 14). Grand means allow for a general ranking and grouping of activities on the basis of emotional intensity (Table 7).

Descriptive Analysis Findings

Activity mean averages show that respondents from the three sites share similar emotional feelings with respect to activity, yet do so with different levels of intensity (Table 5; Figures 8, 9, and 10). Activity mean averages also show

parallels in emotional responses between Otter Key and Longbeach residents. The emotional responses of Island Park residents towards boating activities

Table 5. Site Responses Averaged by Activity.

Activity Mean Averages by Site						
Pleased / Annoyed						
Site	Activity					
	Sail	Anchor	Live Aboard	Power	Jet Ski	Fishing
Longbeach	.75	-.08	-2.81	-1.00	-2.81	-.08
Otter Key	1.54	1.10	-2.03	-.36	-2.33	1.21
Island Park	1.71	.95	-.49	-.71	-1.50	1.74
Excited / Calm						
Site	Activity					
	Sail	Anchor	Live Aboard	Power	Jet Ski	Fishing
Longbeach	-.50	.11	2.08	1.03	2.33	-.22
Otter Key	.03	.13	1.79	.87	2.14	-.31
Island Park	-.44	-.25	.16	.35	.80	-.77
Helpless / In Control						
Site	Activity					
	Sail	Anchor	Live Aboard	Power	Jet Ski	Fishing
Longbeach	-.64	-1.58	-2.17	-1.64	-2.47	-.81
Otter Key	.62	-.51	-1.05	-.97	-1.69	-.13
Island Park	.35	-.06	-.75	-.93	-1.58	.36

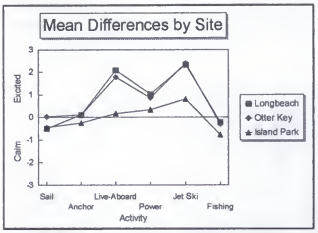


Figure 8. Average Site Differences by Activity: Arousal Variable.

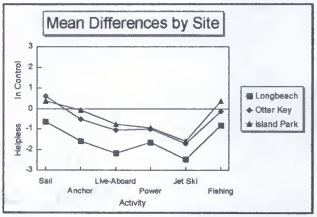


Figure 9. Average Site Differences by Activity: Control Variable.

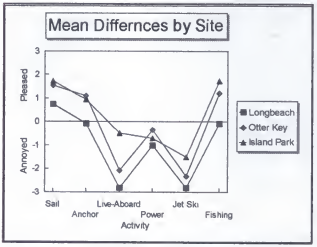


Figure 10. Average Site Differences by Activity: Pleasure Variable

generally trend in the same direction as those of Otter Key and Longbeach residents, but the parallels are not as striking. In addition, activity mean averages demonstrate that live-aboard anchoring, power boating, and jet ski activities generate the highest levels of annoyance, excitement and helplessness, among survey respondents. Conversely, the activities of overnight anchoring, sailing, and fishing generate the highest levels of pleasure, calm, and control among survey respondents.

Averages of activity means for each distance (Table 6, Figures 11, 12, and 13) illustrate that shore residents are generally less annoyed, more calm, and more in control the farther away an activity takes place. Respondents share similar emotional feelings with respect to activity over distance, yet activities evoke different levels of emotional intensity. These factors suggest that distance is an important criterion for evaluating activity tolerance.

Grand means indicate the general association of higher levels of pleasure and control with lower levels of arousal. Conversely, higher levels of arousal are associated with lower levels of control and pleasure (Figure 14). A general grouping of the activities (Table 7) corroborates activity mean averages by suggesting that the lowest levels of annoyance, arousal, and helplessness are associated with sailing, fishing and anchoring. The highest levels of annoyance, arousal, and helplessness are associated with the activities of power boating, live aboards and jet skis (Table 7).

Table 6. Mean Activity Responses Averaged by Distance.

Mean Activity Responses Averaged by Distance				
Pleased / Annoyed				
Activity	Distance from Shoreline (in feet)			
	200	400	600	800
Sailing	.21	1.42	1.82	2.06
Anchoring	-.76	.63	1.33	1.60
Live Aboard	-2.28	-1.88	-1.43	-1.31
Power Boat	-1.97	-.83	-.01	.25
Jet Ski	-2.43	-2.34	-2.23	-1.62
Fishing	.06	.89	1.45	1.52
Excited / Calm				
Activity	Distance from Shoreline (in feet)			
	200	400	600	800
Sailing	.33	-.37	-.60	-.89
Anchoring	1.17	.08	-.59	-1.07
Live Aboard	1.86	1.50	.95	.71
Power Boat	1.62	.87	.25	-.04
Jet Ski	2.17	1.94	1.66	1.25
Fishing	.31	-.50	-.83	-.91
Helpless / In Control				
Activity	Distance from Shoreline (in feet)			
	200	400	600	800
Sailing	-.29	.16	.30	.11
Anchoring	-1.17	-.70	-.49	-.52
Live Aboard	-1.46	-1.34	-1.22	-1.37
Power Boat	-1.65	-1.21	-.95	-.89
Jet Ski	-2.13	-1.91	-1.84	-1.81
Fishing	-.51	-.24	0.00	.03

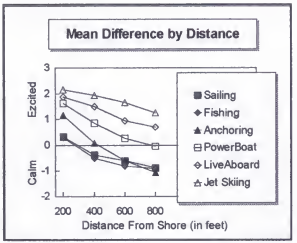


Figure 11. Average Activity Differences by Distance: Arousal Variable.

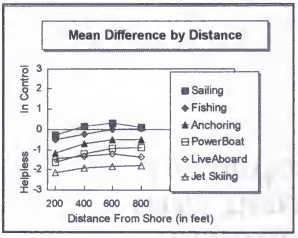


Figure 12. Average Activity Differences by Distance: Control Variable

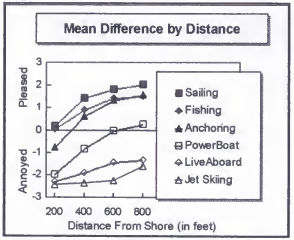


Figure 13. Average Activity Differences by Distance: Pleasure Variable.

Table 7. Activity Grand Means: Intensity of Feeling Associated with Activities.

Activity Grand Means (mean of distance and site averages)			
Activity	Emotional variable		
	Pleasure	Arousal	Control
Sailing	1.36	-.34	.09
Anchoring	.96	-.05	-.72
Fishing	.96	-.45	-.19
Power Boat	-.67	.71	-1.18
Live Aboard	-1.75	1.30	-1.33
Jet Ski	-2.18	1.80	-1.91

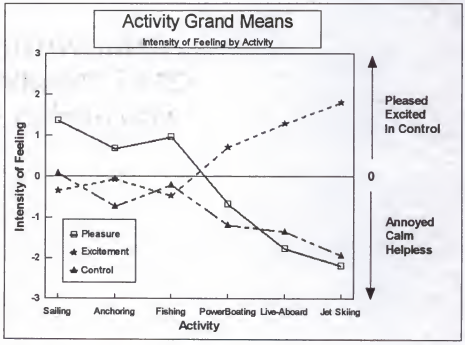


Figure 14. Activity Grand Means: Intensity of Feeling Associated with Activities.

Verifying General Trends in Emotional Response to Boating Activities

T-Test Methods

Descriptive observations are corroborated by two sample t-tests. The magnitude of the t-statistic indicates the strength of emotional similarity by comparing emotional response means. A strong emotional similarity is affirmed by a low t-statistic (accept hypothesis that there is no difference between variables). Conversely, weak statistical associations are documented by a larger t-statistic (reject hypothesis that there is no difference between variables).

T-tests are used to examine emotional similarities on the basis of location, activity, and distance. T-test results, for emotional and descriptive variables, are summarized by the letters (S or N). The letter S, indicates a significant difference (alpha .05) existing in emotional responses between variables. The letter N indicates no significant difference existing in emotional responses between variables.

T-tests provide a measure of how similar emotional responses are between specific activities, irrespective of distance and site (Table 8). This allows activity rankings (Table 7) to be more precisely defined. Emotional response similarities also are tested between sites for each boating activity (Table 9). In addition, emotional similarities between specific distances, irrespective of activity, or site, are tested (Table 10). Last, emotional responses between sites for each distance are compared (Table 11).

T-Test Findings

Respondents exhibit similar emotional responses toward the activities of live-aboards and power boating and for the activities of fishing and sailing (Table 8).

Table 8. T-Test Results Comparing Collective Emotional Response by Activity. Pleasure (P); Arousal (A); Control (C).

T-Test Results: Emotional Response by Activity

Activity		Anchor			Sail			Live Aboard			Power			Jet Ski			Fishing		
		P	A	C	P	A	C	P	A	C	P	A	C	P	A	C	P	A	C
Anchor	P				S			S			S			S			S		
	A					N			S			N			S			S	
	C						S			S			S			S			S
Sail	P							S			S			S			N		
	A								S			S			S			N	
	C									S			S			S			N
Live Aboard	P										N			S			S		
	A											N			S			S	
	C												N			S			S
Power	P													S			S		
	A														S			S	
	C															S			S
Jet Ski	P																S		
	A																	S	
	C																		S
Fishing	P																		
	A																		
	C																		

Otter Key and Island Park residents respond emotionally the same to the boating activities of overnight anchoring, sailing, power boating, and fishing

(Table 9). Longbeach responses are the same with that of Otter Key, for power boating, and with that of Island Park for jet skiing (Table 9).

Table 9. T-Test Results Comparing Site Emotional Response by Activity. Pleasure (P); Arousal (A); Control (C).

T-Test Results. Site Differences in Emotional Response by Activity										
Activity		OK vs IP			OK vs LB			IP vs LB		
		P	A	C	P	A	C	P	A	C
Anchoring	P	N			S			S		
	A		N			N			N	
	C			N			S			S
Sailing	P	N			N			S		
	A		N			N			N	
	C			N			S			S
Live Aboard	P	S			S			S		
	A		S			N			S	
	C			N			S			S
Power Boat	P	N			N			N		
	A		N			N			S	
	C			N			N			N
Jet Ski	P	S			S			N		
	A		S			S			N	
	C			N			N			N
Fishing	P	N			S			S		
	A		N			N			N	
	C			N			N			S

T-test results (Table 10) support emotional trends (Figures 11, 12, and 13) by showing that attitudes toward activities are significantly affected by distance - differences between distances are accentuated with proximity to the shoreline. Significant differences exist in emotions towards activities between

near areas (200 feet) and far areas (800 feet). These differences are seen to plateau beyond 600 feet. The only anomaly to this trend is that similarity exists between 200 and 400 feet for the control variable.

Table 10. T-Test Results Comparing Collective Emotional Response by Distance. Pleasure (P); Arousal (A); Control (C).

T-Test Results. Emotional Response by Distance

Distance		200 feet			400 feet			600 feet			800 feet		
		P	A	C	P	A	C	P	A	C	P	A	C
200 feet	P				S			S			S		
	A					S			S			S	
	C						N			S			S
400 feet	P							S			S		
	A								S			S	
	C									N			N
600 feet	P										N		
	A											N	
	C												N
800 feet	P												
	A												
	C												

Emotional comparisons between sites, for distance (Table 11), broadly mirror collective similarities (Table 10). Emotional responses between sites, towards activities, become more similar with distance from the shoreline. However, specific instances of attitudinal congruence between Otter Key and Island Park residents are identified for distances of 400 and 600 feet. However, significant differences in attitude exist between Island Park and Longbeach residents, for pleasure and control variables, at all distances.

Table 11. T-Test Results Comparing Site Emotional Response by Distance. Pleasure (P); Arousal (A); Control (C)

T-Test Results. Site Differences in Emotional Response by Distance												
Distance		OK vs IP			OK vs LB			IP vs LB				
		P	A	C	P	A	C	P	A	C		
200 feet	P	S			S			S				
	A		S			N			S			
	C			N			S			S		
400 feet	P	N			S			S				
	A		N			N			S			
	C			N			S			S		
600 feet	P	N			N			S				
	A		N			N			N			
	C			N			S			S		
800 feet	P							S				
	A								N			
	C									S		

Describing Complex Emotional Response Patterns to Boating Activities

ANOVA Methods

Descriptive analyses provide a visual representation of emotions related to activity, distance and location. T-test results provide a statistical measure of the strength of those associations. Multi-way ANOVA models complement descriptive analyses and t-tests by providing a statistical method of simultaneously and independently testing the significance of the complex interactions between activity, distance and location separately, for each emotional variable.

An ANOVA model incorporating individual variation utilizes the survey

responses for the pleasure variable only. Arousal and control responses are analyzed in a simplified ANOVA model, which does not consider individual variation effects. The simplified model compensated for missing values attributed to arousal and control responses. These missing values created computational problems when analyzed by an ANOVA model which included a parameter for individual variation. Missing values were the result of incomplete responses by survey respondents. The frequency of non-response for the pleasure variable (pleased / annoyed adjectival pair) was not significant enough to interfere with the more robust ANOVA calculation that incorporated individual variation as a parameter.

The ANOVA model used for the pleasure variable first provides an estimate of variation among individual scores and calculates the residual error that cannot be attributed to individual variation alone. In doing so, the model measures the difference in average individual scores as they relate to an aggregated site average score. This compensates for potential outliers (overly tolerant and intolerant respondents). In other words, the estimate of Individual variation quantifies internal personal characteristics of the survey respondents, independent of location, activity, and distance.

Residual error includes potential model error introduced due to a misunderstanding of questions, mislabeling of responses, or response possibilities not precisely reflecting the respondents true feelings. For instance, emotional intensity is measured incrementally (+3 to -3). This forces

respondents to chose the whole number which most closely approximates their true feelings. As such, emotional rounding due to the construction of the survey questions may account for a portion of the residual model error. Main effects and variable interactions are tested in comparison to the residual error. Main effects and interactions determined to be significant in explaining residual model error (error not accounted for by individual variation) are displayed in Table 12.

A simplified ANOVA model which does not consider the effects of individual variation is used to determine if each emotional variable contributes significantly to attitudinal differences related to location, distance, and activity (Table 13).

ANOVA Findings

ANOVA results for the pleasure variable indicate that the individual annoyance average is 1.45 away from the collective site average. For example, if the collective average is -1, individual averages would vary from .45 to -2.45. Residual error, not accounted for by individual variation, was calculated to be 2.38. Thus, results for the pleasure variable indicate that individual error (1.45) accounts for nearly one third of the total model error of 3.83 (1.45 + 2.38).

Main and interactive effects of location, distance, and activity are determined to be significant on the basis of p values < .05. The interaction of Activity*Distance(site) was found to be not significant (Table 12).

Results from the simplified ANOVA model indicate that all main and

Table 12. Results from the ANOVA Model that Included Individual Variation.

ANOVA Results for Model Including Individual Variation		
Effect / Interaction	p value	Significant
Ind_ID(site)	.0001	Yes
Site	.0276	Yes
Activity	.0001	Yes
Distance(Site)	.0001	Yes
Site*Activity	.0001	Yes
Activity*Distance(Site)	.0580	No

interactive effects of location, distance, and activity are significant for each emotional variable (pleasure, arousal, and control), on the basis of p values < .05 (Table 13). Consequently, each emotional variable contributes significantly, in its own right, towards explaining differences in shore resident tolerance based on location, distance, and activity. ANOVA results further corroborate

Table 13. Results from the Simplified ANOVA Model.

ANOVA Results for Simplified Model				
Effect / Interaction	Pleasure	Arousal	Control	Significance
	p-value	p-value	p value	
Site	.0001	.0001	.0001	Yes
Activity	.0001	.0001	.0001	Yes
Distance(Site)	.0001	.0001	.0001	Yes
Site*Activity	.0001	.0004	.0001	Yes
Activity*Distance(Site)	.0001	.0001	.0001	Yes

descriptive statistics and t-tests by showing that location plays an important role in explaining attitudinal differences towards activities in general, and with respect to the distance at which those activities take place.

Quantifying Shore Resident Tolerance for Specific Boating Activities

Regression Analysis Methods

ANOVA least square mean (LSMEAN) estimates used in the regression analysis are generated from the more robust ANOVA model which incorporates the effects of individual variability as applied to the pleasure variable. Simplified ANOVA results are not considered. LSMEAN's generated by the ANOVA interaction Activity*Distance(Site) are used in a regression to determine tolerance breakpoints for specific activities. ANOVA LSMEAN's are averages within each category (activity, distance, site), calculated in a manner that estimates emotional intensity averages on the basis of what would have happened in a balanced survey (equal numbers of people per site, etc.). ANOVA LSMEAN estimates of activity by distance, for each site, are located in Appendix D.

Regression predictions are based on estimates of the collective pleasure or annoyance elicited by activities. Accordingly, the regression model predicts tolerance breakpoints farther from shore as activity annoyance increases. However, pleasurable feelings were derived from viewing some activities, such as sailing and fishing. As a result, the regression model also predicts tolerance

breakpoints inland, based on the intensity of pleasure derived from some activities. The range of predictions emphasizes the magnitude of pleasure or annoyance evoked by certain activities.

For the purpose of mapping shore resident tolerance zones, regression predictions inland are truncated to the shoreline, and predictions extending beyond the anchorage area are cropped to the outer-most boundary of the site.

Regression Analysis Findings

General activity distance breakpoints of 401, 447, and 749 feet were estimated for Island Park, Otter Key, and Longbeach, respectively (Table 14). These distances corroborate the descriptive analysis by demonstrating that Island Park and Otter Key residents are, on average, more tolerant of boating activities than Longbeach residents.

Tolerance distances generated for each activity, found in Table 15, support descriptive results, which indicate that anchoring, sailing, and fishing are the most tolerated activities, while live aboards and jet skis are the least tolerated. The results also corroborate the large differences in activity tolerance, based on estimated distance breakpoints, between Longbeach residents and their counterparts at Otter Key and Island Park (Table 14). Estimated regression distances fall within parameters defined (Appendix C) by identifying the distances between which, averaged pleasure emotions most closely approximate zero (indifference).

Table 14. General Activity Tolerance Breakpoints by Site.

Regression Output by Site						
Site	Intercept (a)	Std error Y	Slope (b)	Std error X Coef	R Square	Distance in Feet*
Island Park	-.7567	.0858	.0018	.0001	.9797	401 (0)
Otter Key	-1.4615	.4396	.0032	.0015	.8156	447 (0)
Longbeach	-3.0185	.1674	.0040	.0003	.9830	749 (0)

* (0) designates out from the shoreline.

Quantifying Relationships Between Emotional Variables

Spearman Rank Correlation Methods

The fourth component of the statistical analysis determines the extent to which responses for each of the three emotional variables (pleasure, arousal, control) are correlated on the basis of location, activity, and distance. A Spearman *rho* statistic was calculated for each location, activity and distance for the control / arousal, pleasure / arousal, and control / pleasure variable combinations. Estimates are presented, in Appendix E. Independence, or lack of correlation between emotional variables, is inferred from a *rho* value between the range of .5 and -.5.

Spearman Rank Correlation Findings

An inspection of the *rho* estimates reveals multiple specific instances where strong and moderate positive and negative correlations are estimated between emotional variables for site, activity, and distance. Spearman *rho*

Table 15. Specific Activity Tolerance Breakpoints by Site.

Regression Output: Island Park						
Activity	Intercept (a)	Std error Y	Slope (b)	Std error X Coef	R Square	Distance in Feet*
Anchoring	-0.5529	.2090	.0028	.0004	.9484	195 (O)
Sailing	.88664	.0945	.0014	.0002	.9576	624 (I)
Fishing	1.0792	.0705	.0011	.0007	.9638	937 (I)
Power Boat	-2.1783	.1318	.0025	.0002	.9703	869 (O)
LiveAboard	-1.4988	.1002	.0019	.0002	.9741	770 (O)
Jet Ski	-2.2763	.0611	.0014	.0007	.9830	1545 (O)
Regression Output: Otter Key						
Anchoring	-1.5897	1.0049	.0061	.0035	.7500	258 (O)
Sailing	-3.3E-9	.7536	.0003	.0026	.6756	0 (O)
Fishing	-.2564	.4082	.0036	.0014	.8650	70 (O)
Power Boat	-2.1282	.7222	.0044	.0025	.7500	481 (O)
LiveAboard	-3.3075	4.1E-9	.0030	1.4E-11	1.0000	1075 (O)
Jet Ski	-2.410	.0314	.0019	.0001	.7500	1253 (O)
Regression Output: Longbeach						
Anchoring	-3.4444	.3574	.0067	.0007	.9725	512 (O)
Sailing	-1.9444	.3539	.0053	.0007	.9586	361 (O)
Fishing	-2.2222	.2755	.0042	.0006	.9601	519 (O)
Power Boat	-4.0000	.3406	.0060	.0007	.9687	667 (O)
LiveAboard	-3.1111	.0657	.0006	.0001	.8962	5091 (O)
Jet Ski	-3.3888	.3012	.0011	.0006	.6000	2095 (O)

* (O) designates out from the shoreline. (I) designates in from the shoreline

results indicate an overall moderately strong positive correlation existing between the pleasure and control variables for site, activity, and distance. Conversely, the results indicate a moderate to strong negative correlation existing between the control / arousal, and pleasure / arousal combinations for site, activity, and distance. These findings demonstrate that feelings of pleasure and control increase, as feelings of arousal decrease, and feelings of pleasure increase along with feelings of control.

In short, independence between the three emotional variables can not be deduced on the basis of the Spearman *rho* statistic. These results corroborate descriptive and quantitative results which illustrate and show similar trends of dependence existing between emotional variables.

CHAPTER 5
GIS ANALYSIS METHODS AND FINDINGS

GIS analysis findings are presented as a series of maps, by site, illustrating bio-physical and social tolerance stress surfaces, and water-use zones. Water-use zones depict areas of low, medium, and high activity compatibility. In addition, GPS data collected during the month of July, 1998, as part of the ongoing boat activity monitoring effort, is aggregated and presented as observed activity frequency zones. Observed boating activity frequencies are compared to water-use zones for each site, providing a visual representation, in the form of vulnerability zones, of the degree to which observed boating activities are congruent with appropriate water-use zones.

Bio-Physical Stress Surfaces - Methods and Findings

Bio-physical stress surfaces for Otter Key, Longbeach, and Island Park, weighted in accordance with the scoring scheme outlined in Table 1, are presented in Maps 1, 2 and 3. These maps illustrate the spatial extent of preferred bottom characteristics for anchor holding, depth ranges, and seagrass beds. The findings indicate that areas of poor bottom holding (soft silt mud) coincide with core anchoring areas at each site. The findings also illustrate the

association of seagrass beds with shallow water (depth < 3 feet).

Social Tolerance Stress Surfaces

Methods

Social tolerance zones for each activity are depicted for Otter Key, Longbeach, and Island Park (Maps 4, 5, and 6). The spatial extent of tolerated and non-tolerated areas is the result of buffering the shoreline to distance breakpoints estimated for each activity, as presented in Table 15. Tolerated areas (light shading) indicate lower social stress. Higher stress is associated with non-tolerated darker-shaded areas.

Findings

Social stress maps provide a visual representation of shore resident tolerance for specific activities. Clearly illustrated is the lack of shore resident tolerance for higher intensity activities such as jet skiing and power boating. In addition, live-aboard anchoring activities are shown to be unacceptable by shore residents at the smaller, more confined sites of Longbeach and Otter Key. Island Park residents tolerate the presence of live-aboard anchoring at the outer fringes of the anchorage. Conversely, greater amounts of low stress social territory is available at the anchorage sites for lower intensity activities such as sailing, short-term, or overnight, anchoring, and fishing.

Water-Use Zones

Methods

Composite stress surfaces incorporating bio-physical and social stress surfaces, depict low, medium, and high stress water-use zones for Otter Key,

Table 16. Acreage Counts by Site for High, Medium, and Low Stress Water-Use Zones. IP = Island Park; LB = Longbeach; OK = Otter Key.

Activity	Site	Acreage				Percent Total			
		High	Med	Low	Total	High	Med	Low	Total
Sailing	IP	0	12	87	99	0	12	88	100
	LB	7	26	13	46	15	57	28	100
	OK	0	5	24	29	0	17	83	100
Anchoring	IP	9	13	77	99	9	13	78	100
	LB	9	28	9	46	20	61	20	100
	OK	10	7	12	29	34	24	41	100
Fishing	IP	0	11	88	99	0	11	89	100
	LB	9	28	9	46	20	61	20	100
	OK	6	4	19	29	21	14	66	100
Power Boat	IP	11	58	30	99	11	59	30	100
	LB	13	28	5	46	28	61	11	100
	OK	4	23	2	29	14	79	7	100
Jet Skiing	IP	11	88	0	99	11	89	0	100
	LB	20	26	0	46	43	57	0	100
	OK	5	24	0	29	17	83	0	100
Live Aboard	IP	16	48	35	99	16	48	35	100
	LB	20	26	0	46	43	57	0	100
	OK	5	24	0	29	17	83	0	100

Longbeach, and Island Park (Maps 7, 8, and 9). Acreage calculations for high, medium and low stress water-use zones (Table 16) provide an estimate of the net useable space contained within a site for specific boating activities. Percent totals allow for an inter-site comparison of the amount of high, medium, and low stress acreage that exists for similar activities (Table 16). Percent area totals may be used to identify sites which are best suited for various activities. Sites with large low stress percent area totals may be best suited for that specific activity.

Findings

Acreage totals reveal that large portions of the Island Park anchorage are suitable for the activities of sailing (87 low stress acres), short-term anchoring (77 low stress acres), and fishing (88 low stress acres). In addition, 35 and 30 low stress acres are available for live-aboard anchoring and power boating activities, respectively. No low stress acreage exists, at any site, for the activity of jet skiing.

Water-use zones for Longbeach indicate that 13 low stress acres exist for the activity of sailing. Nine low stress acres are available for short-term anchoring and fishing. However, due to the relatively intolerant nature of shore residents, and the presence of large seagrass beds, only five acres of low stress area exists for power boating, and none exists for jet skiing and live-aboard anchoring.

Similar circumstances exist at Otter Key for power boating, live-aboard anchoring, and jet skiing activities. However, due to smaller amounts of seagrass and greater shore resident tolerance, more low stress acreage is available at Otter Key for the activities of short-term anchoring (12 acres), sailing (24 acres), and fishing (19 acres) than at Longbeach.

Acreage calculations (Table 16) indicate that 88 and 83 percent of the Island Park and Otter Key anchorages, respectively, are comprised of low stress areas for the activity of sailing. In addition, 89 percent of Island Park, and 66 percent of the area at Otter Key, consists of low stress areas for fishing. However, very little low stress acreage exists at any site for the activities of jet skiing, and power boating. Percent area totals show that very little acceptable space exists for any activity at the Longbeach site. However, 57 to 61 percent of the total area falls under the medium stress category for any given boating activity.

Caution must be exercised when interpreting these results as other important factors must be taken into consideration (such as activity space requirements) when determining whether or not a site is appropriate for specific activities. Ninety percent of 30 acres may still not be enough area for some activities to take place comfortably. Conversely, activities such as short-term and live-aboard anchoring, and fishing require relatively little space (Wilson, 1964, Ashton, 1971). Given enough space, a site possessing large amounts of low stress acreage for an activity is generally best suited for that activity.

Observed Boating Activity Frequency Surfaces

Methods

The frequency of observed boating activities for Otter Key, Longbeach, and Island Park illustrated in Maps 10, 11, and 12 is the result of combining boat travel path observations compiled for the four randomly selected survey days occurring during the month of July, 1998. The four survey days included July 4 (Independence Day), July 6, July 11, and July 19. Three of the sample days occurred on weekends.

Boat travel paths for each sample day are converted to grids and combined. For the purpose of displaying preliminary results, low frequency refers to grid cells impacted by activities on one survey day, and medium frequency refers to cells containing crossed paths for two sample days. High frequency grid cells resulted from travel routes crossing for three or four sample days. There were no overlapping cells for the activity of anchoring at any site. Therefore, frequency stress surfaces could not be constructed. Anchoring locations for subsequent survey days are represented only as points for Otter Key and Longbeach.

A modified approach to mapping activity frequency accumulations was required for Island Park. Monitoring indicated that the most common boating categories at Island Park consisted of moored live-aboard and stored vessels. Under perfect conditions, these stationary activities would accumulate spatially as single grid cells. However, while technically considered to be stationary

activities, wind and tides can result in drift distances over time exceeding even several grid spaces. As a result, very few cells overlapped temporally for independent stationary activities. Displaying individual frequency surfaces for each activity resulted in uniform low frequency maps with illegibly small grid squares at the selected 25 foot grid size.

Due to the limited number of survey days, and the resolution of the Island Park data as it is printed in map form (1:15,000), grid cells had to be increased to 75 feet for stationary activities. In addition, all stationary activities, including short-term and live-aboard anchoring, and wet storage, were aggregated, as were all observed transiting activities, such as dinghying, jet skiing, and power boating, for the purpose of displaying frequency accumulations. In other words, Island Park maps display only two activities - stationary boating and transiting boating.

Findings

The preliminary results of the activity frequency analysis show that power boating impacts a much greater proportion of the Otter Key and Longbeach sites than does other activities. The results for Otter Key and Longbeach also indicate that observed fishing activities are taking place on seagrass beds. Only short-term anchoring activities seem to be consistently taking place within low stress zones.

Island Park results indicate that transiting activities seem to be confined to a fairly tight travel corridor around the Island Park peninsula, ending at the

O'Leary's restaurant dock. The highest frequency grid cell counts adjacent to O'Leary's dock suggest that this restaurant is the origin and destination for much of the site's transiting boating activities. Conversely, stationary activities display a more random spatial pattern. A more distinct spatial pattern will emerge for moored activities as the number of survey days increases.

Vulnerability Zones

Methods

Vulnerability zones are derived from the combination of water-use zones (Maps 7 and 8) and observed boating activity frequency stress surfaces (Maps 10 and 11). Potentially vulnerable areas for Otter Key and Longbeach are illustrated in Maps 13 and 14. It is not possible to develop vulnerability indices for Island Park. This is due to the fact that suitability grids (combined bio-physical and social grids) were developed specific to each activity. They can not, therefore, be used as a basis for comparing impacts measured from grouped activity frequency grids.

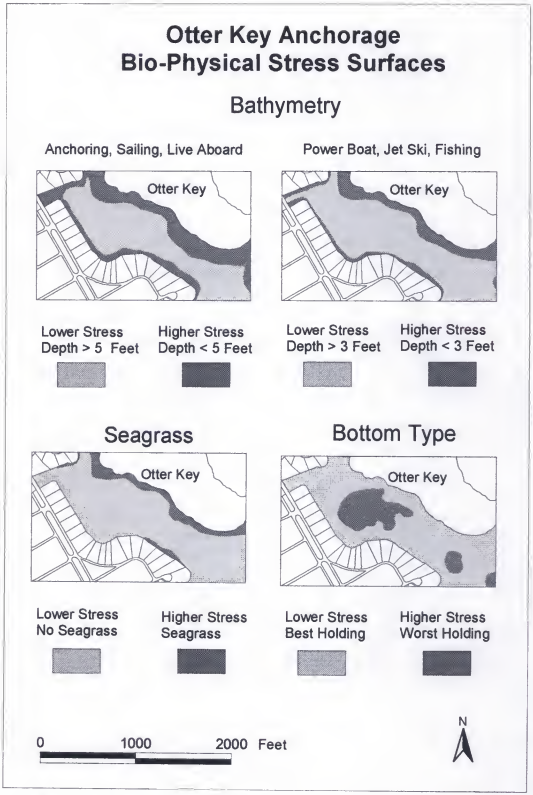
Vulnerability zones depict the relationship between low, medium, and high boat traffic and low, medium, and high stress areas within a site. Areas exhibiting the greatest vulnerability to boat traffic are shaded black. Areas of low vulnerability are shaded light gray.

The magnitude and spatial extent of vulnerable areas provides a visual representation of the congruence between monitored activities and water-use

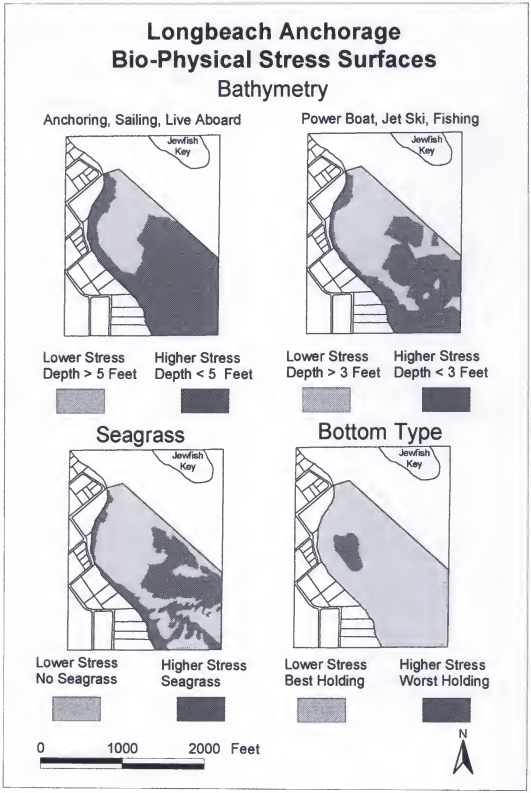
zones. The spatial extent of potentially vulnerable areas will undoubtably increase as the survey continues.

Findings

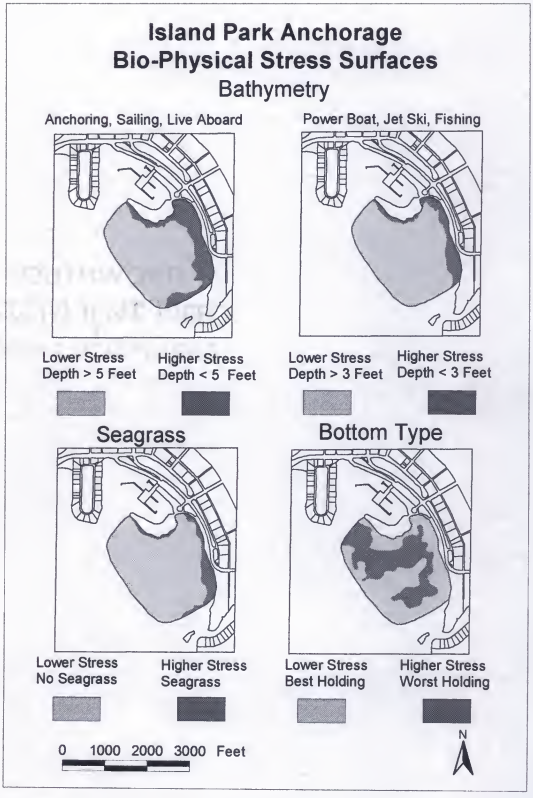
The results indicate that much of the Otter Key and Longbeach anchorages exhibit low vulnerability towards boating activities. Low vulnerability does not mean that environmentally and socially sensitive areas do not exist - it simply means that sensitive zones are not being compromised by the observed boating activities. For example, preliminary results suggest that power boating activities generate the greatest potential environmental and social pressure at Otter Key and Longbeach. Impacts from jet skiing and fishing are visible but not widespread. This is due in part to the relative infrequency of occurrence for jet skiing and fishing activities at the two sites. The activities of short-term anchoring, and sailing show no visible impacts.



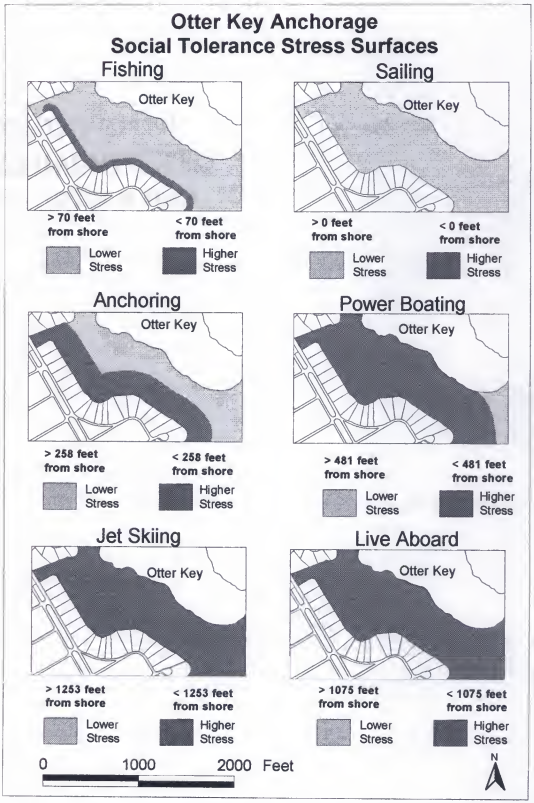
Map 1. Otter Key Anchorage: Bio-Physical Stress Surfaces.



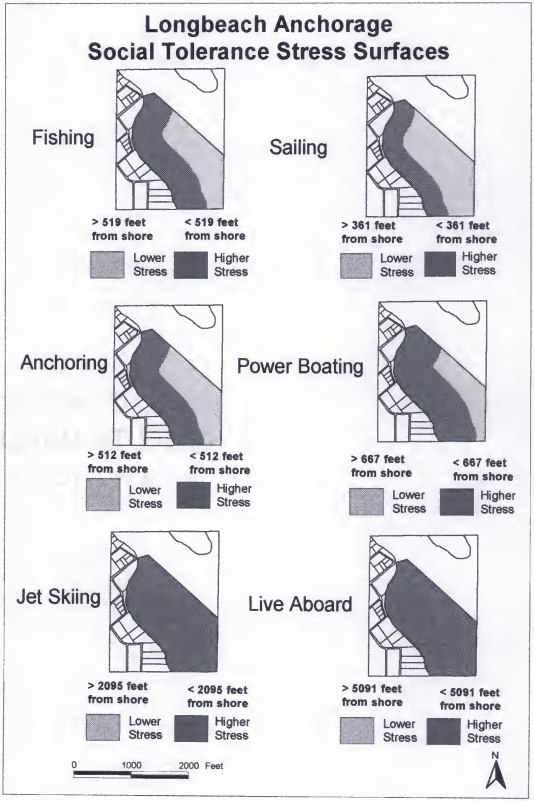
Map 2. Longbeach Anchorage Bio-Physical Stress Surfaces.



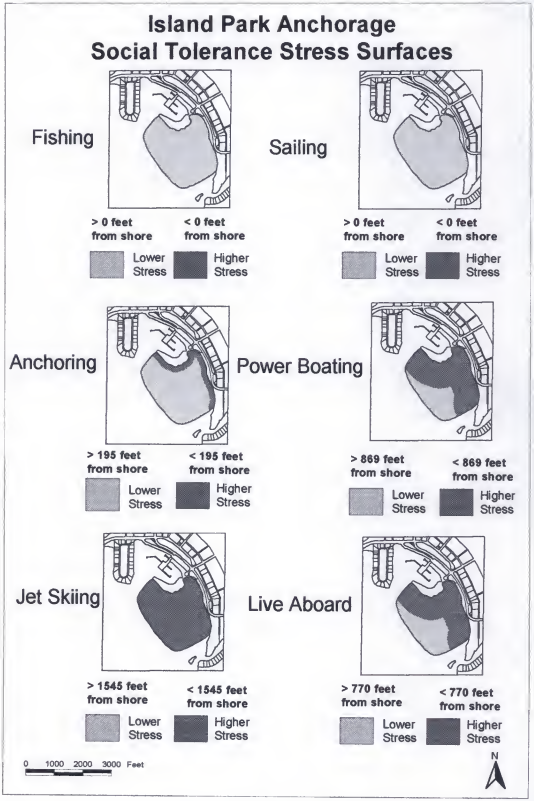
Map 3. Island Park Bio-Physical Stress Surfaces.



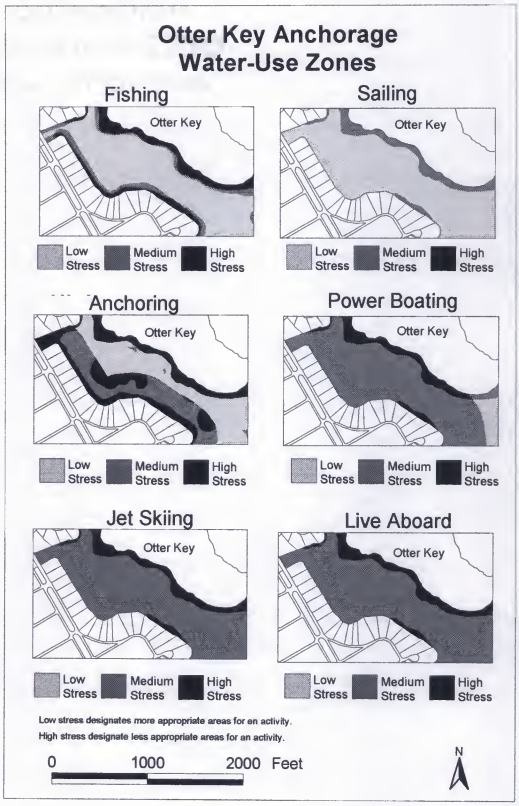
Map 4. Otter Key Anchorage: Social Tolerance Stress Surfaces.



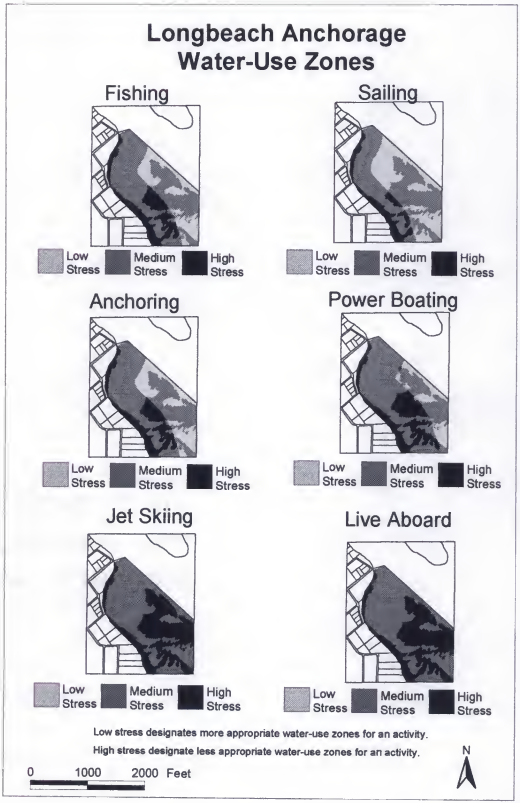
Map 5. Longbeach Anchorage: Social Tolerance Stress Surfaces.



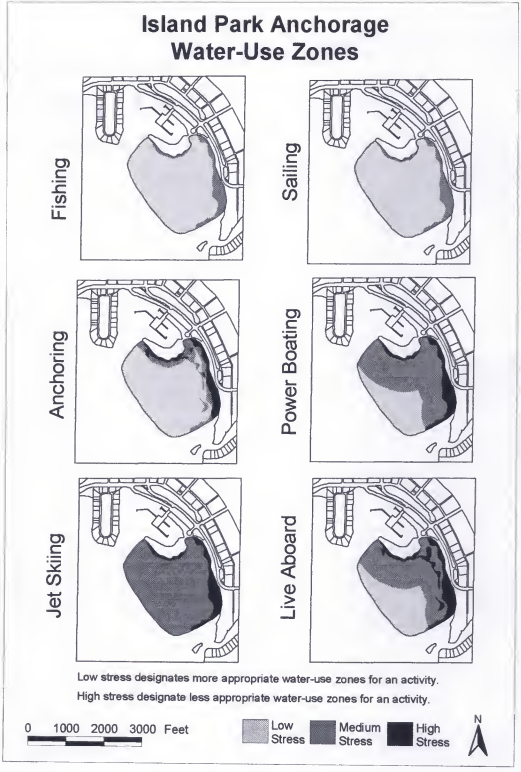
Map 6. Island Park Anchorage: Social Tolerance Stress Surfaces.



Map 7. Otter Key Anchorage: Water-Use Zones.



Map 8. Longbeach Anchorage: Water-Use Zones



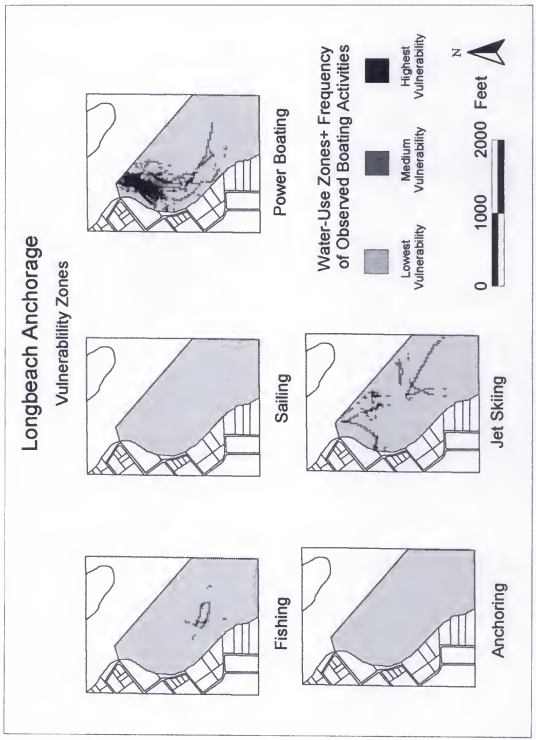
Map 9. Island Park Anchorage: Water-Use Zones.

Map 10. Otter Key Anchorage: Frequency of Observed Boating Activities.

Map 11. Longbeach Anchorage: Frequency of Observed Boating Activities.

Map 12. Island Park Anchorage: Frequency of Observed Boating Activities.

Map 13. Otter Key Anchorage: Vulnerability Zones.



Map 14. Longbeach Anchorage: Vulnerability Zones.

CHAPTER 6
SUMMARY AND CONCLUSIONS

This final chapter provides a summary of the research methods, reviews the findings of this research consistent with the stated aims, and highlights the major conclusions. This chapter also includes a methodological critique and a discussion of the ways in which this research promotes non-regulatory anchorage management efforts. Lastly, opportunities for future research are presented.

Summary of Methods and Findings

The water-use zoning strategy presented is defined by five research aims or components: (1) Characterizing recreational boating activities; (2) defining bio-physical areas; (3) defining shore resident tolerance; (4) mapping and analysis; and (5) monitoring boating activities. A summary of the methods and findings related to each aim are as follows.

Aim One

Recreational boating activities were defined and characterized on the basis of a Sarasota Bay boat census (Antonini and Box 1996) and a boater survey (Antonini et al. 1994). Common recreational boating activities for the

purpose of this study are defined as overnight anchoring, live-aboard anchoring, sailing, fishing, power boating, jet skiing. The average boat length is 25 feet. The average draft of sailboats and power boats is four feet and three feet, respectively.

Aim Two

Important bio-physical features were identified by consensus of local boaters and marine experts (Antonini et al. 1994; Antonini et al. 1998), and characterized by field surveys using GPS, depth-sounder, and biologist / divers observations. Features inventoried included depth, sea grass beds, bottom type, and shoreline. Bio-physical attributes were converted to GIS databases, thereby providing the input for bio-physical stress surfaces.

Aim Three

Shore resident tolerance towards selected recreational boating activities was elicited through the implementation of a self-administered written survey. The shore resident population, 214 individuals at the three test sites, was inventoried and contacted. Eighty-five people responded, providing a 40 percent overall response rate. The survey return breakdown indicates a much higher response rate for the Otter Key and Longbeach sites (60 percent) than for Island Park (36 percent). The shore resident survey was intended to satisfy three specific goals.

The first goal was to define specific distance breakpoints at which shore residents at each site become "intolerant" or "indifferent" towards specific

recreational boating activities. Estimated tolerance breakpoints for specified boating activities were generated by regressing ANOVA LSMEAN's for the pleasure variable against distance. The appropriateness of estimated tolerance breakpoints were verified by comparing them to distance bounds generated by averaging pleasure variable responses for each distance. The findings show that Island Park and Otter Key residents on average, are more tolerant of boating activities than Longbeach residents. In addition, shore residents have greater tolerance for anchoring, sailing and fishing than they do for power boating, jet skiing, and anchoring live-aboards. Social stress surfaces for recreational boating activities were generated by buffering the shoreline by estimated breakpoint distances.

The second goal was to describe shore resident emotional response towards specified recreational boating uses with respect to activity, distance, and location. The purpose of this goal was to gain a better understanding of shore resident tolerance towards boat recreation, and more specifically, to determine whether or not shore residents at the three test sites shared similar emotional responses towards recreational boating activities. The results indicate that, in general, shore resident attitudes towards specific activities, and the distance at which those activities occur, differ significantly between the three test sites. However, specific results for activity responses by site indicate that Otter Key and Island Park residents share a similarity in emotional responses towards the activities of overnight anchoring, sailing, power boating, and fishing.

Longbeach residents do not share significant emotional response similarities, with respect to activity, with either Otter Key or Island Park.

Results also indicate attitudinal congruence between Otter Key and Island Park residents for specific distances (400 and 600 feet) at which activities take place. Otter Key and Longbeach residents share similar attitudes, at all distances, for the arousal variable. In addition, significant differences exist in emotional response between Island Park and Longbeach residents, for pleasure and control variables, at all distances. Lastly, significant differences were found to exist between Island Park and Longbeach residents, for the arousal variable, at distances closer than 400 feet.

These findings point to a general difference in site emotional response with respect to activity and distance. However, similarities in emotional response were found to exist between Otter Key and Island Park residents with respect to certain boating activities and specific distances. Longbeach resident emotional response towards boating activities and distances differ significantly from those of Otter Key and Island Park residents.

The third goal was to determine whether a correlation exists between emotional variables (pleasure, arousal, and control) on the basis of activity, distance, and location. The purpose of this goal was to test for independence of the emotional variables in order to confirm the Mehrabian theory of independence of these particular emotional variables. Spearman *rho* values show that correlation exists between each of the three variables for most

activities at most distances. Therefore, the findings of the Mehrabian study are not confirmed.

Aim Four

Map-defined water-use zones are developed for each boating activity by integrating bio-physical and social tolerance zones. A multi-overlay composite scoring approach, as detailed in McCartney (1991), is utilized to define and display water-use zones depicting areas of low, medium, and high activity compatibility. In addition, observed boating activity frequencies are compared to water-use zones for each site, providing a visual representation, in the form of vulnerability zones, of the degree to which observed boating activities are congruent with appropriate water-use zones.

Water-use and vulnerability zone findings are site and activity specific, permitting few generalizations. However, acreage counts for water-use zones indicate that greater amounts of low stress acreage exists for activities such as sailing, overnight anchoring, and fishing, than for power boating, jet skiing, and anchoring live-aboards. Conversely, no low stress acreage is identified for jet skiing. Vulnerability zones show that Otter Key and Longbeach anchorages exhibit low vulnerability towards most boating activities - overnight anchoring, sailing, and fishing. This suggests that sensitive social and bio-physical zones are not being compromised by these types of boating activities. Conversely, areas of high and medium vulnerability are identified for power boating and jet skiing.

Aim Five

Activity monitoring provides the necessary mechanism for evaluating derived water-use zones and management needs. For instance, do boating activities really compromise sea grass beds? Are shore resident tolerance zones continually violated? How often do boats actually anchor in areas of less desirable holding? How often do boats travel through shallow water areas? Are jet skis really a constant nuisance at the sites? Anecdotal experiences suggest that these circumstances exist. However, it is necessary to quantify these occurrences through a scientific process which measures the actual frequency and spatial extent of boating activities.

On-site monitoring, with a GPS and laser range-finder, allows for a determination of the geographical extent of on-the-water recreational boating activities. Monitoring offers a way to relate boating activities with proposed water-use zones, in order to determine a measure of social, bio-physical, and activity congruence. Congruances are mapped as vulnerability zones.

Frequency counts, based on the first month of boat monitoring, indicate that power boating activities generate the greatest potential environmental and social pressure at Otter Key and Longbeach anchorages. Power boating activities at Otter Key are generally restricted to a travel corridor running through the center of the anchorage. The greatest frequency of power boating activities at Longbeach are found around the Moore's Stone Crab and MarVista restaurant docks.

Sufficient data is not yet available to create vulnerability zones for Island Park. However, a frequency analysis of boating activities at Island Park reveals a diffuse spatial pattern of stationary anchoring activities (live-aboard, wet storage, overnight anchoring) and a concentrated occurrence of transient activities (power boating and jet skiing) along the northern border of the site adjacent to Oleary's restaurant dock.

Conclusions

The following general conclusions can be made on the basis of the research findings.

1. Significant variation exists, within each test site, with respect to individual emotional responses towards boating activities, and the distance at which those activities occur.
2. Significant variation exists, between test sites, with respect to shore resident emotional responses towards boating activities, and the distance at which those activities occur.
3. Activity type is an important criterion in determining shore resident emotional response, regardless of location and distance.
4. The distance from the shoreline at which an activity takes place is an important criterion in determining shore resident emotional response, regardless of location and activity type.

The following specific conclusions can be made on the basis of the

research findings.

1. The typical shore resident is a retired, year-round resident, college educated, over 60 years of age (most are older than 70), with an income of between $50,000 and $100,000, who owns his or her shorefront home. In addition, Otter Key and Longbeach residents typically own at least one boat or personal watercraft.

2. Overnight anchoring, sailing, and fishing generate the lowest levels of annoyance, arousal, and helplessness. Power boating and anchoring live-aboards generate moderate levels of annoyance, arousal and helplessness. Jet skiing generates overwhelming levels of annoyance, arousal and helplessness.

3. Otter Key and Island Park residents share greater similarities in emotional response to the activities of overnight anchoring, sailing, and fishing with each other than they do with Longbeach residents. Longbeach residents share emotional response similarities for power boating with Otter Key residents, and for jet skiing with Island Park residents.

4. Significant differences exist in emotional response towards activities between near areas (200 feet) and far areas (800 feet). These differences are seen to plateau beyond 600 feet. Shore residents are less annoyed, less aroused, and feel more in control towards recreational boating activities the farther away they occur.

5. Significant differences exist between all sites with respect to emotional response towards activities occurring within 200 feet of the shoreline. Shore

residents at the three sites respond with significantly different levels of emotional intensity towards activities occurring near the shoreline.

6. Otter Key and Island Park residents share greater similarities in emotional response to the distance at which activities occur with each other than they do with Longbeach residents.

In summary, shore resident emotional response towards distance and activity type is similar. For example, respondents at the three test sites generally prefer the same activities over others, and generally are more favorable of any activity, the farther from the shoreline that it takes place. However, residents at the different sites view activity type and distance criteria with significantly different levels of emotional intensity. As a result, location is shown to be an important criterion in determining shore resident emotional response toward recreational boating activities and the distance at which activities take place. Consequently, specific results should not be generalized to other anchorages. Nevertheless, Otter Key and Island Park residents do show greater similarities in emotional response towards boating activities compared to each other than compared to their Longbeach counterparts. This conclusion runs counter to the anticipated outcome that the residents of the upscale single-family neighborhoods (Otter Key and Longbeach) would respond with greater similarity to each other than to Island Park condominium owners. It was expected that Otter Key residents would be the least tolerant of boating activities, followed by Longbeach residents. Island Park residents were

expected to be the most tolerant towards recreational boating activities, and that expectation is confirmed.

The empirical analysis identifies optimal water-use solutions which incorporate what the majority of shore-residents at each site prefer. To the extent that majority preferences drive the market for land use, this analysis identifies optimal water-use solutions that maintain maximum shore-front land-values[7].

Methodological Critique

GPS Survey

The place-based approach taken in this study focused the GPS field-surveys on relatively small areas in order to provide very precise data as a basis for a large-scale, high resolution mapping effort. Bathymetric data were captured every few feet along each transect. Seagrass boundaries and bottom characteristics were surveyed roughly every twenty feet along each transect providing an even spatial distribution of points. However, the positional accuracy of those points has not been verified. Technical information provided with the TDC2 and ProXR GPS receiver indicates that sub-meter accuracy can be attained with that equipment with a one second occupation time (Trimble, 1997). This means that each position taken (one position per second) is within

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[7] The general theory regarding externalities and their impact upon land values is in Thrall (1987).

one meter of its actual location. However, positional accuracy increases with occupation time. For example, an occupation time (length of stay at one location) of 180 seconds is recommended for control points (Trimble, 1997). The collection of positions on-water generates a confounding and unquantifiable positional error due to boat drift. Thus, a brief occupation time will provide for sub-one meter accuracy while minimizing the effect of drift. For the purposes of this research, land-side control points were occupied for 180 seconds while on-water test locations were occupied for one to three seconds.

A number of factors, (including multi-pathing, the number of visible satellites, the elevation of satellites, the distance between the nearest radio beacon and the roving receiver, and the position of dilution of precision (PDOP), may combine to degrade positional accuracy. A high level of positional accuracy was attained through the selection of critical settings within the TDC2 Asset Surveyor software, which automatically restricts datalogging to periods of favorable satellite configurations. Favorable datalogging time-periods were identified prior to surveying, by predicting future satellite configurations on the basis of a current satellite almanac, which is automatically collected each time the GPS receiver is turned on.

Shore Resident Survey

Reliable findings and conclusions are dependent on a survey that is comprehensible, as well as on the obtainment of a high response rate and a representative sample. The survey was beta-tested at a public meeting held by

Florida Sea Grant for area shore residents. Ten individuals who owned shorefront properties agreed to remain after the meeting and complete the survey. Their comments led to revisions intended to improve the organization and wording of the survey. However, continued confusion over the meaning of adjectival word pairs (calm \ excited and helpless \ in control) persisted through the implementation of the final survey. The following excerpt from an e-mail reflects this general confusion:

> We have some questions about the Shore Resident Survey. Part 2. Does "excited" mean "extremely pleased" or does it mean "angry"? In both cases a person can get excited. Part 3. This part seems to be useless. We have no idea what is meant by "in control" or "helpless". These words are meaningless. How could anyone be "in control" of what people do in the bay? We are not water policemen, nor members of the City Council".

Early comments by survey participants indicated the need for additional clarification of the survey. As such, a letter of clarification (Appendix A) was either mailed or hand delivered to each shorefront resident. Nevertheless, a general misunderstanding of the meaning of adjectival pairs used to describe the emotions of arousal and control may weaken certain results and conclusions related to those variables. No confusion is linked to the adjectival pair pleased \ annoyed. Therefore, results of this adjectival pair were used for the final delineation of social tolerance zones.

Each resident identified as living adjacent to one of the three test anchorages was either hand-delivered or mailed a questionnaire. Sixty percent

of the Longbeach and Otter Key shore residents returned surveys. However, only 35 percent of Island Park shore residents responded to the survey. The low return rate from Island Park condominium residents may be due to a disinterest in participating in the survey, physical separation from the anchorage by a four-lane highway, and/or a sense of protection from living in a gated high-rise apartment. Low returns for Island Park may also be attributed, in part, to managers who did not aggressively advertise the survey and impart to the condominium owners a sense of importance regarding the completion of the survey. However, it may be assumed that those who participated are the most affected and concerned amongst this community.

An attempt was made to distribute and collect surveys from the entire shore resident population at the three test sites. This technique is referred to as a census. However, in the absence of overwhelming coercion not all individuals will respond. The proportion of the population which does respond is referred to as a convenience sample. Convenience sampling involves surveying willing participants. This method is practical in that it relies on readily available units such as students in a school, or patients in a waiting room (Fink, 1995). However, the sample is opportunistic and voluntary. Thus, "participants may be unlike most of the constituents in the target population" (Fink, 1995; p 23). A convenience sample requires a relatively high response rate to increase the potential that an un-biased sample has been selected from the population. Therefore, one consequence of a low return for Island Park is that results may

not reflect the collective feelings of the condominium residents who live there.

A random sampling technique may not provide better results than convenience sampling, considering that the sample was drawn from a small population. In addition, replacement sampling (for non-respondents) would be limited to those few residents who were not included in the initial random sample. Despite drawbacks, the convenience sampling technique is appropriate in such cases where the target population is small, and restricted to specific locales (Fink, 1995).

Mapping and Analysis

GPS settings for the mapping of bio-physical features were chosen to maximize positional accuracy. However, an undetermined amount of error is introduced through the interpolation of GPS-defined points to define homogeneous bio-physical areas as vector-based polygons. In addition, a certain amount of resolution can be lost when converting vector databases to a raster-based grid data model: The shape and location of areas can be generalized. Vector to raster error is minimized in this analysis by the selection of five-foot grid cells, which are considered to provide a high resolution grid representation of study site features, relative to map scale and study site area.

A raster format is well suited to the type of spatial analysis conducted as part of this research, in which the precise representation of an object (i.e. seagrass bed boundary) is less important than its relative location to other features (i.e. a boat travel path). A raster-based model accommodates a multi-

overlay composite scoring approach by allowing grid layers to be easily combined, with the numerical values assigned to each overlapping cell accumulating spatially as a composite score (Environmental Systems Research Institute, 1994).

Methodological Assumptions

The scoring scheme developed to determine the magnitude of bio-physical and social stress is based primarily on the results of a charette. Charette participants ranked environmental concerns as the most important anchorage management consideration (Antonini et al., 1998). Social concerns were also highly ranked, but exact weights were not identified. Shore resident concerns are a primary focus of this study. Thus, bio-physical and social weighting assigned the highest relative weights to seagrass beds and to areas proximate to shore residents. As such, results do reflect a weighting bias congruent with the study's primary goal of minimizing boating impact to seagrass beds and shore residents.

This research is limited to a study of shore resident tolerance and an inventory of specific bio-physical variables. However, there are myriad social, physical and biotic elements that define and characterize an anchorage. The incorporation of additional data layers including buffer zones around water-based hazards such as submerged vessels, and seagrass beds would improve site characterization and the accuracy of derived water-use zones.

It is also, recognized that the attitudes of boaters is an important missing

element to a full comprehension of the anchorage site geography. The interactions between boaters would be a critical element in defining the personal space requirements necessary for determining the carrying capacity of an anchorage. For the purpose of this study, it is assumed that recreational boaters are mobile and therefore have the opportunity to independently act and adjust their locations. However, the attitudes of boaters towards one another may force recreational outcomes that contribute to bio-physical and social violations (i.e. a boater may choose a less favorable location because of perceived crowding at the more optimal locations).

A measure of boater attitudes is not included in this research but boat activity monitoring provides an initial measurement of what boaters do. This enables the incorporation of boater activity information into the development of water-use zones. Future studies of boater attitudes may discover that a boater's choice of activity and location reflect, in part, his attitudes towards coincident activities, allowing boat activity monitoring as a surrogate for resource intensive attitudinal surveys.

Promoting Non-Regulatory, Anchorage Management Efforts

This research promotes non-regulatory anchorage management efforts advanced through the cooperative partnership between the Boaters Action and Information League (BAIL), the West Coast Inland Navigation District (WCIND), the Southwest Florida Regional Planning Council (SWFRPC), the Florida

Department of Environmental Protection (FDEP), and the Florida Sea Grant Program (FSG). The non-regulatory approach to anchorage management is, in part, implemented through the actions of a Regional Harbor Board (RHB), as well as through efforts to inform and educate boaters of the environmental and social consequences of their potential actions.

A RHB has been established to act as an advisory council to help implement the non-regulatory management effort by addressing anchorage resource problems using a conflict resolution approach. The RHB is charged to designate anchorages in need of active management based on demonstrated environmental damage, chronic user conflict, or overcrowding. Water-use zones provide valuable information to the RHB regarding the types of activities that are most compatible with site geography. In addition, use-frequency, types of uses, and vulnerability zones (which illustrate the potential for environmental and social conflict), can be used by the RHB to determine the need to promote either active or passive management strategies.

In Florida, length-of-stay restrictions are the driving force behind non-regulatory anchorage management efforts. Many coastal communities in Southwest Florida have agreed to suspend or relax current length of stay restrictions in favor of first relying on the mediation efforts of the RHB. The proposed water-use zoning strategy can be used to support efforts, like the Vero Beach mooring field project (Ankerson, 1998) to spatially define areas of an anchorage that are best suited to permanent and temporary moorings.

Research indicates that boaters care about the environment and will adopt responsible behavior when provided with the right kinds of information (Antonini et al., 1994). Boaters typically rely on NOAA small-craft charts for navigation purposes. However, according to Antonini et al. (1994), NOAA charts do not provide boaters with the level of detail on the environment required to make responsible resource use decisions in areas of sensitive habitat. This lack of information "frustrates efforts to promote stewardship, respect for community concerns, and adequate protection of marine resources" (Antonini and Box, 1996; p52). Map-based results generated from this research provide large-scale, high-resolution, up-to-date information on anchorage resources. These map products have inherent value to boater education efforts. They can be incorporated into existing and proposed boater education products (anchorage guide book, web page, place-mats, nature-tourism). It is the intent of such publications to convey to local mariners a better understanding of the boating geography and appreciation for bay resources, thereby, promoting non-regulatory waterway management.

Zoning often pre-supposes some form of regulatory intervention. However, a scientifically-based water-surface zoning strategy applied within the context of a non-regulatory management effort can be used both to build voluntary consensus and as the basis for legally defensible and enforceable anchorage management plans.

Opportunities for Future Research

Carrying Capacity Measures

The identification of water-use zones and potentially vulnerable areas provides a measurement of the net useable space required, as a first step, to define site carrying capacity. A growing number of municipalities, including Vero Beach and Venice, have or are considering the installation of permanent and transient moorings as a way of managing recreational anchorage activities. The water-use zoning methodology provides the basis for a rational approach to determining the optimal number and locations for anchorage moorings. The number and location of moorings, placed within acceptable use-zones, could be estimated purely on the basis of the physical space requirements of boats. However, optimal mooring capacity and location also could include the personal space requirements of boaters.

Generalizing Shore Resident Tolerance

Research conclusions indicate that it may be inappropriate to generalize specific results to other locations. Results indicate a statistically significant degree of individual and site variation with respect to activity and distance, even though descriptive statistics suggest a similar demographic profile for the test sites. Additional ANOVA tests focusing on demographic information could be performed, to determine if site differences in emotional response are related to age, gender, income, or education. If emotional response can be explained demographically, shore resident tolerance may be generalized in order to make

site-specific social surveys unnecessary.

A further analysis of additional site criteria, such as property value, age of the home, length of ownership, and lot size, might provide a better explanation of differences in social tolerance by site. Upon reflection, these site characteristics point to significant differences between Longbeach and Otter Key. Longbeach properties are much larger, and private. In addition, Otter Key properties seem to experience a much greater turn-around-rate, as reflected by the many "For Sale" signs in front of homes there. It is hypothesized that residents who have resided in their home for a long period of time and require greater privacy, are less tolerant of nearby boating activities.

Additional Weighting Scenarios

Bio-physical and social tolerance weighting schemes reflect an effort to protect seagrass beds and minimize social stress. The selected weighting scheme does not presume to be the single ideal. Future research might explore ways to assign variable weights with greater precision. A delphi approach which solicits expert judgement, similar to that offered by McCartney (1991) and Thrall et al. (1988), could be employed as a method to rank and assign specific weights to bio-physical and social variables. Additional weighting scenarios emphasizing specific bio-physical and social components would provide various management options.

Conclusion

The value of any academic research must be considered in terms of its

contribution to the knowledge of the field of inquiry. There is, however, additional value derived from research that is also useful to practitioners. This research endeavors to meet academic requirements and fulfil local and regional management needs. This study fits neatly within the Florida Department of Environmental Regulation's "place-based" management concept. It also provides a more holistic, systematic and map-based approach to recreational water-use zoning. The results promote a better understanding of the interrelationships between water users, shorefront residents and the natural environment. The research also provides a useful methodology and practical site-specific information for community-based non-regulatory anchorage management.

APPENDIX A

Survey Questionnaire

Questionnaire Control Number: _____

SHORE RESIDENT SURVEY

FOR

WATERWAY MANAGEMENT

A survey conducted by the Florida Sea Grant Program at the

University of Florida with funding from the

Florida Cooperative Extension Service and the

U.S. Department of Commerce Coastal Services Center

October 1997
Sarasota, Florida

UNIVERSITY OF
FLORIDA

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SHORE RESIDENT SURVEY FOR WATERWAY MANAGEMENT

We are asking you to participate in a study being carried out by the University of Florida concerning near- shore boating activities in Sarasota Bay. The three boating sites that we have chosen include Otter Key, Longbeach, and Island Park. You have been identified from the Sarasota County Property Appraisers file or through the resident manager of your condominium. To the best of our knowledge, we have been able to identify **ALL** property owners or people who live adjacent to each site. In order for the results of this survey to be truly representative of your opinions, it is essential that each property owner or resident participate. We feel strongly, as we hope you do, that your opinions should be taken into account in the formulation of public policies for managing boating activities in Sarasota Bay.

This questionnaire should take about 20 minutes to complete. My research assistant, Charles Sidman, will be calling some of you over the next several days to verify your receipt of the questionnaire. We are enclosing a self-addressed stamped envelope with the questionnaire for those of you who we can not reach by phone but would like to participate. Charles is using this data for his doctoral dissertation.

We hope that this study will offer guidelines to incorporate the views of shore residents into the anchorage planning and management process, and in this way, help maintain the value of your property, while improving upon your waterfront business or residential enjoyment.

We want to be sure that the conclusions reached in this study are realistic. We therefore place great importance on your willingness to participate in this survey. However, we understand that your participation is voluntary. You do not have to answer any questions that you do not want to answer.

You may be assured of complete confidentiality. Your name will never be placed on the questionnaire. The survey results will be reported only in summary form. Individual responses will never be reported and will not be made available to any group soliciting goods and services. Kindly note that no monetary compensation is made for completing the questionnaire.

We would be pleased to answer any questions you may have concerning the research procedures. Our phone number is (352) 392-6233. I can also be reached on my boat at Longboat Key Moorings (941) 378-8019. Please leave a message, including your name and phone number, and we will promptly return your call. Charles Sidman, my research assistant, can be reached by e-mail at cccf@nervm.nerdc.ufl.edu

Your cooperation is greatly appreciated.

Gustavo A. Antonini
Professor and Extension Specialist
Charles F. Sidman

Equal Opportunity/Affirmative Action Institution

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November, 10 1997

Dear Shore Resident.

Thank you for your interest in participating in our Shore Resident Survey. Early comments by participants in the survey indicate the need for some clarification of the questionnaire. I received the following questions from one resident that you, also, may wish to have clarified.

"We have some questions about the Shore Resident Survey. Part 2. Does "excited" mean "extremely pleased" or does it mean "angry"? (In both cases a person can get excited.) Part 3. This part seems to be useless. We have no idea what is meant by "in control" or "helpless". These words are meaningless. How could anyone be "in control" of what people do in the bay? We are not water policemen, nor members of the city council".

Florida Sea Grant will use your responses tp Part 1 of the survey to develop a strategy for waterway management. This strategy is based on information from the Shore Resident Survey and other field data that we have collected for the Otter Key, Longbeach, and Island Park anchorages. WE well be combining this information to develop maps that depict areas that are best suited for various boating activiities. Floreda Sea Grant will be distributing these "educational" maps to area boaters to foster an increased awareness of the environmental and social benefits of safe and responsible boating.

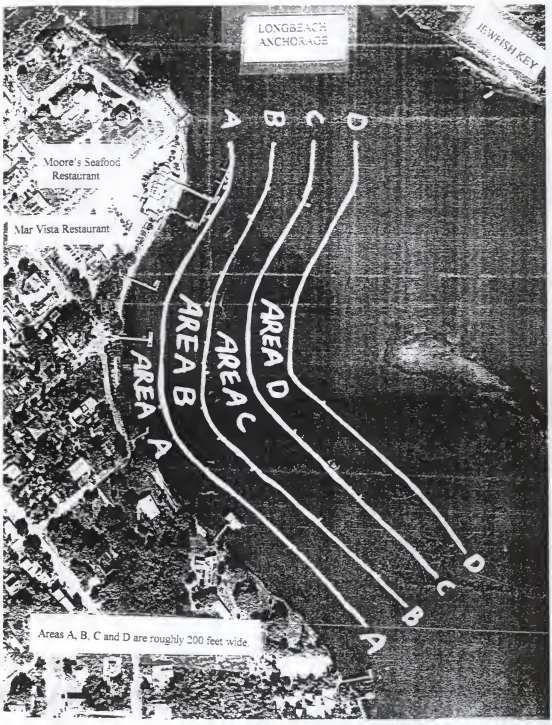
I will use your responses to Parts 2 and 3 for purely "academic" purposes as I prepare my Doctoral dissertation (I an a graduate student at the University of Florida). I will construct shore resident profiles to determine if there are differences in shore resident tolerances towards various boating activities. This may allow me to predict tolerances at other sites without having to implement a comprehensive survey of the residential populations there - the Cartographic Research Laboratory is committed to map and study other anchorage locations along the Southwest Florida coast.

Your pro or con positions on the specific issues in the survey are established in Part 1. It is then important that you answer Parts 2 and 3 on your **first reaction** to each question - you need not carefully analyze the meanings of the specific words. The word pair choices presented in parts 1, 2 and 3 reflect the three emotional components used in the Mehrabian survey method. To clarify, excited / calm means the degree to which you are "moved" by a situation wether by being pleased or angry. The helpless / in control word pair may seem unnecessary, or downright obvious, but it comprises an emotional dimension that when combined with your responses to parts 1 and 2 may allow me to better understand your feelings toward different boating activities.

Thanks again for participating in this survey. I am confident that your responses will lead to improved waterway management approaches. I am certain that your help will be important to the successful completion of my dissertation.

Sincerely,

Charles Sidman


LONGBEACH
ANCHORAGE
JEWFISH KEY
A
B
C
D
Moore's Seafood
Restaurant
Mar Vista Restaurant
AREA D
AREA C
AREA B
AREA A
D
C
B
A
Areas A, B, C and D are roughly 200 feet wide.

I. BOATING ACTIVITIES IN YOUR NEIGHBORHOOD

An increase in boating in Sarasota Bay has led to greater use of coastal resources. One result of this has been a growing number of boating activities closer to the shore and increased concern about how to maintain the coast's attractiveness for its residents. We would like to know your opinion regarding boating activities near the shore where you live.

On the attached photograph you will see four contour lines marked A, B, C, and D. Each represents different distances from your property shoreline. Contour line A is closest to the shoreline where you live while contour line D is the farthest. The contour lines are 100 feet apart.

We would like you to tell how you feel about boating activities by selecting between the word pairs below. Some of the following word pairs might seem unusual, but you will probably feel more one way than the other. Please put a check mark (Example: ___: _✔_ : ___) closer to the word which best describes your feelings. The more appropriate that word seems, the closer you put your check mark to it.

PART 1.

*(1) We would like to know whether you feel pleased or annoyed by someone **SAILING**, at each contour line A, B, C and D. (Please check a space for each contour)*

Along contour line A:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line B:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line C:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line D:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**

*(2) We would like to know whether you feel pleased or annoyed by someone **ANCHORING THEIR SAILBOAT** at each contour line A, B, C, and D. (Please check a space for each contour)*

Along contour line A:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line B:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line C:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line D:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**

*(3) We would like to know whether you feel pleased or annoyed by someone **LIVING ABOARD THEIR BOAT** at each contour line A, B, C, and D. (Please check a space for each contour)*

Along contour line A:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line B:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line C:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line D:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**

*(4) We would like to know whether you feel pleased or annoyed by someone **POWER BOATING** at each contour line A, B, C, and D. (Please check a space for each contour)*

Along contour line A:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line B:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line C:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line D:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**

*(5) We would like to know whether you feel pleased or annoyed by someone **JET SKIING** at each contour line A, B, C, and D. (Please check a space for each contour)*

Along contour line A:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**
Along contour line B:	**pleased**	___:	___:	___:	___:	___:	___:	___ **annoyed**

Along contour line C: **pleased** ____ : ____ : ____ : ____ : ____ : ____ : ____ **annoyed**

Along contour line D: **pleased** ____ : ____ : ____ : ____ : ____ : ____ : ____ **annoyed**

(5) We would like to know whether you feel pleased or annoyed by someone ***FISHING*** *at each contour line* A, B, C, and D. *(Please check a space for each contour)*

Along contour line A: **pleased** ____ : ____ : ____ : ____ : ____ : ____ : ____ **annoyed**

Along contour line B: **pleased** ____ : ____ : ____ : ____ : ____ : ____ : ____ **annoyed**

Along contour line C: **pleased** ____ : ____ : ____ : ____ : ____ : ____ : ____ **annoyed**

Along contour line D: **pleased** ____ : ____ : ____ : ____ : ____ : ____ : ____ **annoyed**

PART 2.

(1) We would like to know whether you feel excited or calm by someone ***SAILING*** *at each contour line* A, B, C, and D. *(Please check a space for each contour)*

Along contour line A: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line B: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line C: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line D: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

(2) We would like to know whether you feel excited or calm by someone ***ANCHORING THEIR SAILBOAT*** *at each contour line* A, B, C, and D. *(Please check a space for each contour)*

Along contour line A: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line B: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line C: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line D: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

(3) We would like to know whether you feel excited or calm by someone ***LIVING ABOARD THEIR BOAT*** *at each contour line* A, B, C, and D. *(Please check a space for each contour)*

Along contour line A: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line B: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line C: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line D: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

(4) We would like to know whether you feel excited or calm by someone ***POWER BOATING*** *at each contour line* A, B, C, and D. *(Please check a space for each contour)*

Along contour line A: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line B: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line C: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line D: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Question 5. We would like to know whether you feel excited or calm by someone ***JET SKIING*** *at each contour line* A, B, C, and D. *(Please check a space for each contour)*

Along contour line A: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line B: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line C: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

Along contour line D: **excited** ____ : ____ : ____ : ____ : ____ : ____ : ____ **calm**

*Question 6. We would like to know whether you feel excited or calm by someone **FISHING** at each contour line* A, B, C, and D. *(Please check a space for each contour)*

Along contour line A: excited ___ : ___ : ___ : ___ : ___ : ___ : ___ calm
Along contour line B: excited ___ : ___ : ___ : ___ : ___ : ___ : ___ calm
Along contour line C: excited ___ : ___ : ___ : ___ : ___ : ___ : ___ calm
Along contour line D: excited ___ : ___ : ___ : ___ : ___ : ___ : ___ calm

PART 3.

*(1). We would like to know whether you feel in control or helpless by someone **SAILING**, at each contour line A, B, C and D. (Please check a space for each contour)*

Along contour line A: in control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line B: in control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line C: in control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line D: in control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless

*(2). We would like to know whether you feel in control or helpless by someone **ANCHORING THEIR SAILBOAT**, at each contour line A, B, C and D. (Please check a space for each contour)*

Along contour line A: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line B: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line C: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line D: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless

*(3) We would like to know whether you feel in control or helpless by someone **LIVING ABOARD THEIR BOAT**, at each contour line A, B, C and D. (Please check a space for each contour)*

Along contour line A: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line B: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line C: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line D: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless

*(4) We would like to know whether you feel in control or helpless by someone **POWER BOATING**, at each contour line A, B, C and D. (Please check a space for each contour)*

Along contour line A: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line B: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line C: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line D: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless

*(5) We would like to know whether you feel in control or helpless by someone **JET SKIING**, at each contour line A, B, C and D. (Please check a space for each contour)*

Along contour line A: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line B: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line C: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless
Along contour line D: In control ___ : ___ : ___ : ___ : ___ : ___ : ___ helpless

*(6) We would like to know whether you feel in control or helpless by someone **FISHING**, at each contour line A, B, C and D. (Please check a space for each contour)*

Along contour line A:	**in control** ___ : ___ : ___ : ___ : ___ : ___ : ___ **helpless**
Along contour line B:	**in control** ___ : ___ : ___ : ___ : ___ : ___ : ___ **helpless**
Along contour line C:	**in control** ___ : ___ : ___ : ___ : ___ : ___ : ___ **helpless**
Along contour line D:	**in control** ___ : ___ : ___ : ___ : ___ : ___ : ___ **helpless**

II. BACKGROUND INFORMATION

At this point we would like to ask you some personal information about where you live. Remember, you need not answer any question that you feel uncomfortable with.

(1) Person Completing Questionnaire
home owner ___
home renter ___
business manager or owner ___

(2) Type of Property
residential ___
time-share ___
restaurant ___
other (specify) _____

(3) If the answer to question 2 is residential, what type of residential property is it?
single-family ___
duplex ___
multi-family condominium ___

(4) If the answer to question 2 is multi-family condominium, what floor do you live on? (*Please specify the floor number*) ___ floor.

(5) If the answer to question 2 is multi-family condominium, does your home face the water? Yes No (*circle one*)

(6) Period of residence if you are a home owner or renter.
year-round ___
seasonal (winter, summer)
other (*specify*) _____

(7) If the answer to question 4 is seasonal, how many months do you typically stay? (*Please fill in the number of months*) ___ months.

(8) Type of water frontage of your home or business.
(*Circle yes for all that apply*)

seawall yes
beach yes
mangrove yes
rip rat yes
other (*specify*) _____

(9) Do you own a boat or water craft? Yes No (*circle one*)

(10) If the answer to question 7 is yes, what type of boat or water craft do you own? (*Circle yes for all that apply*)

power yes
sail yes
jet ski Yes
kayak Yes
canoe yes
other (*specify*) _____

(11) Do you own a dock? Yes No (*circle one*)

(12) If the answer to question 8 is yes, do you use your dock for sunbathing or fishing or docking your boat? Yes No *(circle one)*

(13) What is your present age? *(please circle your answer number.)*

1. 20 - 29 years of age
2. 30 - 39 years of age
3. 40 - 49 years of age
4. 50 - 59 years of age
5. 60 - 69 years of age
6. 70 or more years of age

(14) Are you? Male Female *(circle one)*

(15) Are you? Married Never Married Divorced Separated *(circle one)*

(16) Do you have any children under the age of 18 living at home?
Yes No (circle one)

(17) Do you have any grandchildren under the age of 18 that frequently visit you at home? *Yes No (circle one)*

(18) What is the highest level of education that you have completed?
(please circle your answer number.)

1. some or all primary school (up to grade 8)
2. some high school (grades 9 through 12)
3. high school completed (finished grade 12)
4. completed vocational school or a two-year college degree
5. some college
6. college graduate
7. completed a graduate of professional degree

(19) Presently you are: *(please circle your answer number.)*

1. working full-time
2. not retired but, working part-time
3. retired but still working
4. retired
5. unemployed

(20) Which of the following categories best describes your household income in 1996 from all sources before you paid taxes? *(please circle your answer number.)*

1. less than $5,000 a year
2. $5,000 to $9,999 a year
3. $10,000 to $14,999 a year
4. $15,000 to $19,999 a year
5. $20,000 to $29,999 a year
6. $30,000 to $39,999 a year
7. $40,000 to $49,999 a year
8. $50,000 to $74,999 a year
9. $75,000 to $99,999 a year
10. $100,000 to $149,999 a year
11. $150,000 to $199,000 a year
12. $200,000 to $499,999 a year
13. $500,000 or more

(21) We would like to hear your views on how local and state authorities might better plan and manage popular boat recreation areas to improve your waterfront enjoyment.

_____
_____
_____
_____
_____
_____

thank you for your cooperation in this survey....

APPENDIX B

Monitoring Strategy

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To: **Anchorage Pilot Project Technical Advisory Committee**
Tom Ankersen, Center for Governmental Responsibility, UF
Dave Burr, SWF Regional Planning Council
Kevin Dugan, Collier County
Chuck Listowski, WCIND
Gary Lytton, Rookery Bay National Est. Res. Reserve
Heather Stafford, FDEP/SWF Aquatic Preserves
John Stevely, Manatee County Extension Service
Ex-Oficio
Will White, Regional Harbor Board

CC: Charles Sidman, UF Research Assistant
Niels West, URI Marine Affairs Scientist

Subject: ***Revised*** Strategy for Monitoring and Evaluating On-the-Water Activities at Selected Anchorages

Date: January 31, 1998

1. Background

A Florida Sea Grant objective of the Anchorage Pilot Program is to provide..."expert scientific services, in the design and quality control of anchorage use monitoring at three sites, to local, regional and state governments." The following sites were selected last year based on their representativeness of on-the-water uses throughout the region: Island Park/Sarasota, Longbeach/Longboat Key; Otter Key/Big Sarasota Pass. A twofold approach to monitoring on-the-water uses has been developed.

2. Shore-Resident Survey

Charles Sidman has undertaken a shore resident survey at these sites to elicit resident attitudes towards on-the-water boating activities, and to determine the physical limits within the near shore zone where conflicts may occur. There are 214 households with water-view locations situated at the three sites. Questionnaires were mailed to residents in late October. Eighty-five have been returned. The

breakdown is as follows: Island Park - 177 sent, 63 returned, 36 percent returned; Longbeach - 15 sent, 9 returned, 60 percent response; Otter Key - 22 sent, 13 returned, 60 percent returned). The low returns from Island Park condominium dwellers may be due to a disinterest in participating in the survey, physical separation from the anchorage by a four-lane highway, and/or a sense of protection from living in a gated hi-rise apartment. It may be assumed that the 35 percent who responded are the most affected and concerned in this community. Questionnaires will be analyzed during 1998.

3. Evaluation of On-the-Water Use Monitoring Strategies
The selection of an appropriate monitoring strategy has been elusive and, as a result, we have experienced delays in implementing a program to monitor boating activities.

(a) Discarded Procedures. We have investigated and discarded three approaches. Originally we proposed to use volunteers to conduct this activity, but this proved unsatisfactory since individuals were unable to commit blocks of time for data gathering. We looked at the use of video recording, which is technically feasible, but ran into objections by the Regional Harbor Board members who felt that the procedure would be too intrusive. We examined the use of periodic aerial surveys to photograph the sites, but determined that the cost would be prohibitive.

(b) Selected Procedure. We have consulted with Professor Niels West at the University of Rhode Island, Marine Studies Program, a recognized expert in statistical survey methods and design, and have decided to implement the monitoring strategy using on-the-water surveys during peak use periods with paid field staff who are trained in data capture using GPS and laser-ranging equipment. We propose to carry-out this activity during the July 1998 - June 1999 period. This will offers sufficient time to analyze the results and report to the Regional Harbor Board by Dec.1999.

4. Description of the Selected Monitoring Strategy
(a) Overall Objective. We have adopted a strategy that will give us the most information for our limited monitoring budget. We discarded a systematic sampling approach, which could under-represent use conditions, and selected a stratified random procedure to selectively sample during peak use periods, when on-the-water uses create competition and conflicts with other water or shore uses. Such situations create social and environmental stresses, induce reactions by political and other entities, which respond by imposing regulatory measures that govern on-the-water activities.

(b) Preliminary Use Assessment. The best available information was used to characterize the types of on-the-water activities, their relative importance, day and time of occurrences, and issues of conflicts associated with each use. This information was gleaned by observations and informal interviews. A data table was constructed for this purpose (see Appendix A-1). Tables A-2, A-3, A-4 summarize this preliminary assessment of on-the-water uses for Island Park/Sarasota, Longbeach/Longboat Key, and Otter Key/Big Sarasota Pass, respectively. The three sites were ranked by relative levels of use, in order to give each location its proportion (fair share) of sample days: Island Park represents about 40 percent of all

types of activities found at the three sites, Longbeach and Otter Key about 30.

(c) Sample Design. This sampling procedure is intended to map boat usage and potential conflicts in three water bodies in southwest Florida. The following parameters were considered in developing the sampling procedure: i- *daily usage pattern*, defined by four categories (early and late mornings, and early and late afternoons); ii- *weekly usage*, defined by two categories (weekend/holiday and weekday) but no distinction was made between Saturday and Sunday, nor was any distinction made concerning which weekday was selected as a sampling day for a specific site; iii- *different usage intensities at the three locations*, which are Island Park, Longbeach and Otter Key.

Based on budgetary considerations, data collection will consist of 34 person days each totaling 7 hours although the actual sampling days total 51 days; the field technician will be working from 1 to 9 hours per day and traveling between each sampling site is expected to take 1 hour. Seventeen data collection days take place during the week (Monday through Friday) while the balance (34 days) occur on weekends.

Several other considerations must be taken into account in developing the sample design. A stratified random approach to ensure the collection of a sufficient sample size was required for Longbeach and Otter Key sites. In addition, it was determined that data logging could be accomplished from land-side monitoring of activities at each of the three sites. Finally, travel time between the three sites was determined to take less than 1 hour, thus all are accessible within any one sampling day. The parameter measurements used in developing the sampling design are presented in Table 1. Specific weekly and daily time allocations for Island Park, Longbeach and Otter Key are given in Tables 2-7. Table 9 contains a listing of each selected random number and corresponding week day and weekend day. The four "traditional" boating holidays (Easter, Independence Day, Labor Day, and Memorial Day) will be sampled separately and are not considered part of the randomly selected monitoring days. Tables 8 and 10 provide the daily hourly, and drive totals for each selected monitoring day. The length of stay at a site for any given time period was calculated on the basis of the total number of hours allocated (tables 2-7), and the predicted time required to monitor anchored boats at the sites. Daily monitoring time periods were also determined on the basis fitting the hours such that monitoring would occur for a minimum of 1 hour on week days and 2 hours on week ends, and only once a day at any given site.

(d) Data Collection Schedule. As indicated above, a stratified random approach has been selected as the means of collecting the field data. One strata consists of the three sampling sites, another the division of the actual sampling during the week and weekends, while the third consists of the four sampling periods during the sampling days (early and late mornings, and early and late afternoons).

The following procedures were used in selecting the sampling days for both weekdays and weekends. A total of 17 weekdays were selected to collect the data for this strata (Table 8). The sampling period was determined to begin on July 1, 1998 and extend through June 30, 1999. A total of 260 weekdays and 105 weekend

days were counted. Each weekend and week day was given a sequential number starting with the first week day and weekend day of the year (January 1) and terminating on the last weekday or weekend day of the year (December 31).

Using a random number generator in the Lotus software program, a total of 17 random numbers (one for each weekday sampling day) were selected resulting in the sampling days illustrated in Table 9. Thus, for March 29 (Table 9), the weekday sampling schedule was drawn from Table 8 where 1 hour will be spent sampling in the early morning at Otter Key, followed by a one-hour data collection in the late morning at Longbeach, finishing with three hours monitoring at Island Park in the late afternoon. for a total of 4 hours of data collection. Alternate days should be the next unselected and suitable weekday.

Similar procedures were used to select the 34 weekend days. The 34 sampling days were drawn from a possible of 105 weekend days included in the January 1 - December 31 sampling period. The selected sampling dates appear in Table 9. The sampling day 102 (Sunday, June 20, obtained from Table 10) calls for a 3-hour sampling effort at Island Park in the early morning, followed by 2 hours in the early afternoon at Longbeach, finishing with 2 hours in the late afternoon at Otter Key. The selection of alternate sampling weekend days is done in the same manner as for selecting alternate weekdays (i.e., next available unselected and suitable weekend day). Tables 9 and 10 present the total number of sampling hours for each observation period at the three study sites.

(e) Data Capture. All boating activities will be surveyed using a Trimble XL GPS, beacon receiver and a TDC2 data logger to collect position and attribute information. A laser range-finder will be used to determine the offset from the observer's location to the position of surveyed feature.

Major boating activities will be surveyed. These include: anchoring (recreational, wet storage, live aboards), fishing (recreational, commercial), sailing, jet skiing, power boats, and tour boats.. Information will be recorded as point (anchored) or line (underway) features.

5. Map Compilation of On-the-Water Use-Intensity Zones
A grid will be constructed to cover the site with the grid cell diameter based on the average size of boat. Point and line field data will be overlain onto the grid to convert to polygon (area) features. Overlays will be nested to derive cumulative feature scores which will describe use intensity zones. Site maps will be compiled to portray weekday/weekend conditions for specific and composite uses.

6. Map Evaluation of Resource Management Needs
The use intensity maps described under item 5 will be overlain onto the inventory maps (showing sea grass, bathymetry, bottom sediments, etc.) to determine if boating activities are occurring within environmentally appropriate zones. Non-congruent uses will be identified. Restricted use may be suggested where current uses can be related to ecological damage.

7. Map Social Tolerance Zones

The use intensity maps described under item 5 will be overlain onto shore resident tolerance boundaries, defined by the responses to the survey described under item 2, to determine if boating activities are occurring within socially acceptable zones. Management alternatives may be suggested where uses extend beyond acceptable limits in order to reduce conflict between boaters and shore residents.

Table 1. Total Time Allocation by Site

	Island Park	Otter Key	Longbeach
Percent Allocation by Site	40	30	30
Total Sampling Effort by Site (MAN HOURS)	13.2 days 92 hours	10.4 days 72 hours	10.4 days 72 hours

assumes a total of 34 man days at 7 hours per day

ISLAND PARK
total allocation 13.2 days = 92 hours

Table 2 Weekly Allocation

	Weekly Allocation		
	Weekday = 20 %	Week-end = 80 %	
allocation	18 hours	74 hours	TOTAL 92 hours

Table 3 Sampling Day Allocation

Sampling totals	Morning		Afternoon	
	Early = 10%	Late = 10 %	Early = 35 %	Late = 45 %
Weekday 18 hours	2	2	6	8
Week-end 73 hours	8	8	26	32

LONGBEACH
Total allocation 10.3 days = 72 hours fudged an hour to get sampling day totals to add to whole numbers

Table 4 Weekly Allocation

	Weekly Allocation		
	Weekday = 20 %	Week-end = 80 %	
allocation	16 hours	56 hours	TOTAL 72 hours

Table 5 Sampling Day Allocation

Sampling totals	Morning		Afternoon	
	Early = 25%	Late = 25 %	Early = 25 %	Late = 25 %
Weekday 28 hours	4	4	4	4
Week-end 36 hours	14	14	14	14

OTTER KEY
Total allocation 10.3 days = 72 hours fudged an hour to get sampling day totals to add to whole numbers

Table 6 Weekly Allocation

	Weekly Allocation		
	Weekday = 20 %	Week-end = 80 %	
allocation	16 hours	56 hours	TOTAL 72 hours

Table 7 Sampling Day Allocation

Sampling totals	Morning		Afternoon	
	Early = 25%	Late = 25 %	Early = 25 %	Late = 25 %
Weekday 28 hours	4	4	4	4
Week-end 36 hours	14	14	14	14

Table 9 Sampling Days for Weekend and Weekday Efforts

weekdays		weekend days	
random #	day	random #	day
4	July 6	3	July 11
53	September 11	6	July 19
81	October 21	11	August 8
92	November 5	16	August 23
97	November 12	19	September 5
113	December 4	20	September 6
122	December 17	21	September 12
126	December 29	23	September 19
131	January 13	24	September 20
153	January 29	28	October 4
194	March 29	29	October 10
199	April 5	30	October 11
216	April 28	35	October 31
231	May 19	39	November 5
234	May 24	40	November 15
240	June 1	45	December 5
258	June 25	49	December 19
		50	December 20
		54	January 3
17 total week days		57	January 16
34 total weekend days		61	January 30
		63	February 6
		68	February 21
		69	February 27
		74	March 14
		75	March 20
		78	March 28
		81	April 10
		85	April 24
		93	May 22
		99	June 12
		102	June 20

Boating Holidays

Weekdays		Weekends	
September 7	Labor Day	July 4	Independence
May 31	Memorial Day	April 4	Easter

TABLE 8 Weekday Monitoring Schedule

DATE (17 DAYS)	DAY OF WEEK	SURVEY TIMES												DAILY HOUR TOTALS	DAILY DRIVE TOTALS	TOTAL DAILY TOTALS
		Otter Key				Longbeach				Island Park						
		Morning		Afternoon		Morning		Afternoon		Morning		Afternoon				
		early	late	early	late	early	late	early	late	early	late	early	late			
July 6	monday				1			1			2			4	2	6
September 11	friday	1					1							2	1	3
October 21	wednesday			1		1						2		4	2	6
November 5	thursday		1					1						2	1	3
November 12	thursday	1							1			2		4	2	6
December 4	friday				1		1							2	1	3
December 17	thursday			1					1					2	1	3
December 29	tuesday					1						2		3	1	4
January 13	wednesday				1									1	0	1
January 29	friday		1					1						2	1	3
February26	friday			1					1	2				4	2	6
March 29	monday	1					1					2		4	2	6
April 5	monday		1						1			2		4	2	6
April 28	wednesday		1			1								2	1	3
May 19	wednesday			1			1							2	1	3
May 24	tuesday	1						1				2		4	2	6
June 25	friday				1	1						2		4	2	6
TIME PERIOD TOTALS		4	4	4	4	4	4	4	4	2	2	6	6	TOTAL 50	TOTAL 24	TOTAL 74
Holidays																
September 7	Labor Day		2				2						2	6	2	8
May 31	Memorial Day			2									2	6	2	8
														TOTAL FOR WEEKDAY AND HOLIDAYS		90 HOURS

TABLE 10 Weekend Monitoring Schedule

DATE (34 days)	DAY OF WEEK	SURVEY TIMES												DAILY HOUR TOTALS	DAILY DRIVE TOTALS	TOTAL DAILY TOTALS
		Otter Key				Longbeach				Island Park						
		Morning		Afternoon		Morning		Afternoon		Morning		Afternoon				
		early	late	early	late	early	late	early	late	early	late	early	late			
July 11	Saturday		2					2			2			6	2	8
July 19	Sunday	2					2						2	6	2	8
August 8	Saturday		2					2						6	2	8
August 23	Sunday			2		2							2	6	2	8
September 5	Saturday				2									4	1	5
September 6	Sunday	2					2					2	2	6	2	10
September 12	Saturday			2		2							2	6	2	8
September 19	Saturday		2					2					2	6	2	8
September 20	Sunday	2							2		2			6	2	8
October 4	Sunday				2		2					2		6	2	8
October 10	Saturday					2							2	4	1	5
October 11	Sunday			2					2	2				6	2	8
October 31	Sunday				2			2						4	1	5
November 14	Saturday	2							2			2		6	2	8
November 15	Sunday						2						2	4	1	5
December 5	Saturday		2					2	2					6	2	8
December 19	Saturday					2						2		4	1	5
December 20	Sunday			2			2						2	6	2	8
January 3	Sunday				2	2						2		6	2	8
January 16	Saturday		2					2					2	6	2	8
January 30	Saturday					2					2			4	1	5
February 6	Saturday	2										2	2	6	1	7
February 21	Sunday				2		2					2		6	2	8
February 27	Saturday	2							2			2		6	2	8
March 14	Sunday			2									2	4	1	5
March 20	Saturday		2					2					2	6	2	8
March 28	Sunday								2			2		4	1	5
April 10	Saturday			2									2	4	1	5
April 24	Saturday		2			2						2	2	6	2	10
May 9	Sunday						2					2	2	6	1	7
May 22	Saturday				2							2		4	1	5
June 5	Saturday			2					2	2				6	2	8
June 12	Saturday	2											2	4	1	5
June 20	Sunday				2			2			2			6	2	8
TIME PERIOD TOTALS		14	14	14	14	14	14	14	14	6	6	26	32	TOTAL 186	TOTAL 55	TOTAL 241
Holidays																
July 4	Independence		2					2					2	6	2	8
April 4	Easter			2			2						2	6	2	8
														TOTAL FOR WEEKENDS AND HOLIDAYS		257 HOURS

Pre daylight savings time hours
early morning 7:00 to 9:00am
late morning 10:00 to 12:00am
early afternoon 1:00 to 3:00pm
late afternoon 4:00 to 6:00pm

Post daylight savings time
early morning 6:00 to 10:00am
late morning 11:00 to 1:00pm
early afternoon 2:00 to 4:00pm
late afternoon 5:00 to 7:00pm

GRAND HOURLY TOTAL 347 HOURS

APPENDIX C

Site Responses for Each Emotional Variable
Averaged by Activity and Distance.

Pleased Annoyed Variable

Sailing					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-1.11	.44	1.56	2.11	.75
Otter Key	.46	2.15	2.00		1.54
Island Park	1.29	1.67	1.90	2.00	1.71
Row Average	.21	1.42	1.82	2.06	**1.36**

Anchoring					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-2.33	-.56	.89	1.67	-.08
Otter Key	-.08	1.69	1.69		1.10
Island Park	.13	.75	1.40	1.52	.95
Row Average	-.76	.63	1.33	1.60	**.68**

Live Aboard					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-3.00	-2.89	-2.67	-2.67	-2.81
Otter Key	-2.69	-2.08	-1.46		-2.08
Island Park	-1.16	-.68	-.17	.05	-.49
Row Average	-2.28	-1.88	-1.43	-1.31	**-1.75**

Power Boating					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-2.89	-1.67	0.00	.56	-1.00
Otter Key	-1.54	.23	.23		-.36
Island Park	-1.48	-1.06	-.25	-.05	-.71
Row Average	-1.97	-.83	-.01	.25	**-.67**

Jet Skiing					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-3.00	-3.00	-3.00	-2.22	-2.81
Otter Key	-2.38	-2.31	-2.31		-2.33
Island Park	-1.90	-1.70	-1.38	-1.02	-1.50
Row Average	-2.43	-2.34	-2.23	-1.62	**-2.18**

Fishing					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-1.44	-.56	.67	.00	-.08
Otter Key	.31	1.54	1.77		1.21
Island Park	1.32	1.68	1.92	2.03	1.74
Row Average	.06	.89	1.45	1.52	**.96**

Excited / Calm Variable

Sailing					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	.67	-.56	-1.00	-1.11	-.50
Otter Key	.46	-1.15	-.23		.03
Island Park	-.13	-.41	-.56	-.67	-.44
Row Average	.33	-.37	-.60	-.89	**-.34**

Anchoring					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	2.22	.56	-.89	-1.44	.11
Otter Key	1.00	-.31	-.31		.13
Island Park	.30	0.00	-.59	-.70	-.25
Row Average	1.17	.08	-.59	-1.07	**-.05**

Live Aboard					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	2.56	2.22	1.89	1.67	2.08
Otter Key	2.46	1.89	1.08		1.79
Island Park	.57	.44	-.13	-.25	.16
Row Average	1.86	1.50	.95	.71	**-1.30**

Power Boating					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	2.22	1.56	.44	-.11	1.03
Otter Key	1.85	.54	.23		.87
Island Park	.79	.51	.08	.03	.35
Row Average	1.62	.87	.25	-.04	.71

Jet Skiing					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	2.67	2.56	2.11	2.00	2.33
Otter Key	2.77	2.23	2.23		2.41
Island Park	1.07	1.02	.63	.50	.80
Row Average	2.17	1.94	1.66	1.25	1.80

Fishing					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	1.11	-.22	-.78	-1.00	-.22
Otter Key	.54	-.54	-.92		-.31
Island Park	-.71	-.75	-.78	-.83	-.77
Row Average	.31	-.50	-.83	-.91	-.19

Helpless / In Control Variable

Sailing					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-1.11	-.67	-.44	-.33	-.64
Otter Key	.23	.77	.89		.62
Island Park	0.00	.37	.49	.56	.35
Row Average	-.29	.16	.30	.11	.09

Anchoring					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-2.22	-1.67	-1.33	-1.11	-1.58
Otter Key	-.92	-.38	-.23		-.51
Island Park	-.37	-.05	.08	.08	-.06
Row Average	-1.17	-.70	-.49	-.52	-.72

Live Aboard					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-2.22	-2.22	-2.11	-2.11	-2.17
Otter Key	-1.23	-1.00	-.92		-1.05
Island Park	-.94	-.81	-.63	-.62	-.75
Row Average	-1.46	-1.34	-1.22	-1.37	-1.33

Power Boating					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-2.22	-1.78	-1.44	-1.11	-1.64
Otter Key	-1.38	-.85	-.69		-.91
Island Park	-1.38	-1.00	-.71	-.67	-.93
Row Average	-1.65	-1.21	-.95	-.89	-1.18

Jet Skiing					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-2.56	-2.56	-2.56	-2.22	-2.47
Otter Key	-2.00	-1.54	-1.54		-1.69
Island Park	-1.84	-1.88	-1.43	-1.00	-1.58
Row Average	-2.13	-1.91	-1.84	-1.81	-1.91

Fishing					
Site	Distance				Column Average
	200	400	600	800	
Longbeach	-1.84	-1.00	-.44	-.33	-.81
Otter Key	-.38	-.08	.38		-.13
Island Park	.30	.35	.38	.40	.36
Row Average	-.51	-.24	0.00	.03	-.19

APPENDIX D

ANOVA LSMEANS

ANOVA LSMEANS for Aggregate Activity*Distance(Site) Interaction		
Site	Distance	LSMEAN
Island Park	200	-0.4.477424
	400	-0.10223038
	600	0.47680470
	800	0.69171699
Longbeach	200	-2.2962930
	400	-1.37037037
	600	-0.42592593
	800	0.07407407
Otter Key	200	-0.98717949
	400	0.20512821
	600	0.32051282

ANOVA results: LSMEAN's for Aggregate Activity*Distance(Site) interaction.

ANOVA LSMEANS for Activity*Distance(Site) Interaction		
Island Park		
Activity	Distance	LSMEAN
Anchoring	200	-.05950148
	400	.57207747
	600	1.38786695
	800	1.55891958
Fishing	200	1.26344202
	400	1.57923150
	600	1.82923150
	800	1.94765255
Jet Ski	200	-1.93420145
	400	-1.74999093
	600	-1.40788566
	800	-1.06578040
Live Aboard	200	-1.16331052
	400	-.68962631
	600	-.22909999
	800	-.01857368
Power Boat	200	-1.64540637
	400	-1.29014321
	600	-.54014321
	400	-.22435374
Sailing	200	1.11033234
	400	1.50506918

ANOVA LSMEANS for Activity*Distance(Site) Interaction		
	600	1.82085865
	800	1.95243760
	Longbeach	
Anchoring	200	-2.33333333
	400	-.55555556
	600	.88888889
	800	1.66666667
Fishing	200	-1.44444444
	400	-.55555556
	600	.66666667
	800	1.00000000
Jet Ski	200	-3.00000000
	400	-3.00000000
	600	-3.00000000
	800	-2.22222222
Live Aboard	200	-3.00000000
	400	-2.88888889
	600	-2.66666667
	800	-2.66666667
Power Boat	200	-2.88888889
	400	-1.66666667
	600	.00000000
	800	.55555555
Sailing	200	-1.11111111
	400	.44444444

ANOVA LSMEANS for Activity*Distance(Site) Interaction		
	600	1.55555556
	600	2.11111111
Otter Key		
Anchoring	200	-.07692308
	400	1.69230769
	600	1.69230769
Fishing	200	.30769321
	400	1.53846154
	600	1.76923077
Jet Ski	200	-2.38461538
	400	-2.30769231
	600	-2.30769231
Live Aboard	200	-2.69230769
	400	-2.07692308
	600	-1.46153846
Power Boat	200	-1.53846154
	400	.23076923
	600	.23076923
Sailing	200	.46153846
	400	2.15384615
	600	2.00000000

ANOVA results: LSMEAN's for Activity*Distance(Site) interaction for specific activities.

APPENDIX E

SPEARMAN *rho* RESULTS

Correlation by Site for Emotional Variables.

Spearman Rank Correlation Results: By Site				
Activity	Distance	C / A	P / A	C /P
Otter Key				
Anchoring	200	-0.33275	-0.16575	0.79033
	400	-0.21114	-0.17396	0.83999
	600	-0.26197	-0.29405	0.84503
Fishing	200	-0.60619	-0.43092	0.55574
	400	-0.44339	-0.11903	0.55098
	600	-0.5027	-0.05216	0.58186
Jet Skiing	200	-0.40311	-0.47073	0.17516
	400	-0.60159	-1	0.60159
	600	-0.60159	-1	0.60159
Live Aboard	200	-0.38829	0.18056	-0.17103
	400	-0.57742	-0.44842	0.07718
	600	-0.61842	-0.87946	0.46654
Power Boat	200	-0.66218	-0.539	0.76191
	400	-0.02041	-0.4721	0.24638
	600	-0.07018	-0.58336	0.36873
Sailing	200	0.18279	-0.05403	0.89004
	400	0.3905	-0.07897	0.71181
	600	0.4056	-0.20663	0.32873
Longbeach				
Anchoring	200	-0.34375	-0.34375	1
	400	-0.17925	-0.62495	0.62042
	600	-0.06252	-0.36682	0.23324
	800	0.12395	-0.2634	0.24217
fishing	200	-0.68333	-0.85732	0.79705
	400	-0.42088	-0.7844	0.71599
	600	-0.35945	-0.98624	0.29033
	800	-0.44076	-0.84436	0.09221
Jet Ski	200	-0.75	0	0
	400	-1	0	0
	600	-0.59346	0	0
	800	-0.67988	-0.60302	0.85923
Live Aboard	200	-1	0	0
	400	-0.69557	-0.57282	0.75
	600	-0.31801	-0.52764	0.81832
	800	-0.42848	-0.40708	0.81832

Spearman Rank Correlation Results: By Site				
Activity	Distance	C / A	P / A	C /P
Power	200	-0.69557	-0.32733	0.5625
	400	-0.6296	-0.84483	0.50289
	600	0.01376	-0.66055	0.08716
	800	0.25118	-0.2944	0.05756
Sailing	200	-0.03252	-0.48703	0.16365
	400	0.40674	-0.33204	-0.09479
	600	0.70365	-0.02243	-0.1096
	800	0.63563	-0.07478	0.35238
Island Park				
Anchoring	200	-0.1628	-0.08591	0.61112
	400	-0.24833	-0.11149	0.49823
	600	-0.04957	-0.03232	0.4324
	800	-0.05155	-0.04674	0.41581
Fishing	200	-0.12449	-0.356	0.38158
	400	-0.10006	-0.29231	0.35748
	600	-0.05109	-0.32534	0.32863
	800	-0.01908	-0.33479	0.27874
Jet Ski	200	-0.35604	-0.24645	0.66127
	400	-0.36083	-0.27855	0.69465
	600	-0.30916	-0.37579	0.65299
	800	-0.24184	-0.45494	0.62962
Live Aboard	200	-0.29969	-0.39023	0.63957
	400	-0.34236	-0.36808	0.6604
	600	-0.12545	-0.26204	0.60075
	800	-0.09909	-0.23041	0.56115
Power	200	-0.1342	-0.27675	0.6493
	400	-0.177	-0.26644	0.61296
	600	-0.16546	-0.27331	0.53696
	800	-0.06644	-0.19392	0.5538
Sailing	200	-0.18537	-0.21749	0.31888
	400	-0.13872	-0.20995	0.21959
	600	-0.07413	-0.02248	0.20521
	800	-0.04894	-0.02258	0.12339

Correlation by Distance for Emotional Variables

Spearman Rank Correlation results: By Distance				
Site	Activity	C / A	P / A	C/ P
200 Feet				
Island Park	Anchoring	-0.1628	-0.08591	0.61112
Longbeach		-0.34375	-0.34375	1
Otter Key		-0.33275	-0.16575	0.79033
Island Park	Fishing	-0.12449	-0.356	0.38158
Longbeach		-0.68333	-0.85732	0.79705
Otter Key		-0.60619	-0.43092	0.55574
Island Park	Jet ski	-0.35604	-0.24645	0.66127
Longbeach		-0.75	0	0
Otter Key		-0.40311	-0.47073	0.17516
Island Park	Live aboard	-0.29969	-0.39023	0.63957
Longbeach		-1	0	0
Otter Key		-0.38829	0.18056	-0.17103
Island Park	Power	-0.1342	-0.27675	0.6493
Longbeach		-0.69557	-0.32733	0.5625
Otter Key		-0.66218	-0.539	0.76191
Island Park	Sailing	-0.18537	-0.21749	0.31888
Longbeach		-0.03252	-0.48703	0.16365
Otter Key		-0.08279	0.05403	0.89004
400 Feet				
Island Park	Anchoring	-0.24833	-0.11149	0.49823
Longbeach		-0.17925	-0.62495	0.62042
Otter Key		-0.21114	-0.17396	0.83999
Island Park	Fishing	-0.10006	-0.29231	0.35748
Longbeach		-0.42088	-0.7844	0.71599
Otter Key		-0.44339	-0.11903	0.55098
Island Park	Jet ski	-0.36083	-0.27855	0.69465
Longbeach		-1	0	0
Otter Key		-0.60159	-1	0.60159
Island Park	Live aboard	-0.34236	-0.36808	0.6604
Longbeach		-0.69557	-0.57282	0.75
Otter Key		-0.57742	-0.44842	0.07718

Spearman Rank Correlation results: By Distance				
Island Park	Power	-0.177	-0.26644	0.61296
Longbeach		-0.6296	-0.84483	0.50289
Otter Key		-0.02041	-0.4721	0.24638
Island Park	Sailing	-0.13872	-0.20995	0.21959
Site	Activity	C / A	P / A	C/ P
Longbeach	Sailing	-0.40674	-0.33204	-0.09479
Otter Key		-0.3905	-0.07897	0.71181
600 Feet				
Island Park	Anchoring	-0.04957	-0.03232	0.4324
Longbeach		-0.06252	-0.36682	0.23324
Otter Key		-0.26197	-0.29405	0.84503
Island Park	Fishing	-0.05109	-0.32534	0.32863
Longbeach		-0.35945	-0.98624	0.29033
Otter Key		-0.5027	-0.05216	0.58186
Island Park	Jet ski	-0.30916	-0.37579	0.65299
Longbeach		-0.59346	0	0
Otter Key		-0.60159	-1	0.60159
Island Park	Live aboard	-0.12545	-0.26204	0.60075
Longbeach		-0.31801	-0.52764	0.81832
Otter Key		-0.61842	-0.87946	0.46654
Island Park	Power	-0.16546	-0.27331	0.53696
Longbeach		0.01376	-0.66055	0.08716
Otter Key		-0.07018	-0.58336	0.36873
Island Park	Sail	-0.07413	-0.02248	0.20521
Longbeach		0.70365	0.02243	-0.1096
Otter Key		0.4056	-0.20663	0.32873
800 Feet				
Island Park	Anchoring	-0.05155	-0.04674	0.41581
Longbeach		0.12395	-0.2634	0.24217
Island Park	Fishing	-0.01908	-0.33479	0.27874
Longbeach		-0.44076	-0.84436	0.09221
Island Park	Jet ski	-0.24184	-0.45494	0.62962
Longbeach		-0.67988	-0.60302	0.85923
Island Park	Live aboard	-0.09909	-0.23041	0.56115
Longbeach		-0.42848	-0.40708	0.81832
Island Park	Power	-0.06644	-0.19392	0.5538
Longbeach		0.25118	-0.2944	0.05756

Spearman Rank Correlation results: By Distance				
Island Park	Sail	-0.04894	-0.02258	0.12339
Longbeach		0.63563	-0.07478	0.35238

Correlation by Activity for Emotional Variables

Spearman Rank Correlation Results: By Activity				
Site	Distance	C / A	P / A	C/ P
Anchoring				
Island Park	200	-0.1628	-0.08591	0.61112
Longbeach		-0.34375	-0.34375	1
Otter Key		-0.33275	-0.16575	0.79033
Island Park	400	-0.24833	-0.11149	0.49823
Longbeach		-0.17925	-0.62495	0.62042
Otter Key		-0.21114	-0.17396	0.83999
Island Park	600	-0.04957	-0.03232	0.4324
Longbeach		-0.06252	-0.33682	0.23324
Otter Key		-0.26197	-0.29405	0.84503
Island Park	800	-0.05155	-0.04674	0.41581
Longbeach		-0.12395	-0.2634	0.24217
Fishing				
Island Park	200	-0.12449	-0.356	0.38158
Longbeach		-0.68333	-0.85732	0.79705
Otter Key		-0.60619	-0.43092	0.55574
Island Park	400	-0.10006	-0.29231	0.35748
Longbeach		-0.42088	-0.7844	0.71599
Otter Key		-0.44339	-0.11903	0.55098
Island Park	600	-0.05109	-0.32534	0.32863
Longbeach		-0.35945	-0.98624	0.29033
Otter Key		-0.5027	-0.05216	0.58186
Island Park	800	-0.01908	-0.33479	0.27874
Longbeach		-0.44076	-0.84436	0.09221
Jet Ski				

Spearman Rank Correlation Results: By Activity				
Island Park	200	-0.35604	-0.24645	0.66127
Longbeach		-0.75	0	0
Otter Key		-0.40311	-0.47073	0.17516
Island Park	400	-0.36083	-0.27855	0.69465
Longbeach		-1	0	0
Otter Key		-0.60159	-1	0.60159
Island Park	600	-0.30916	-0.37579	0.65299
Longbeach		-0.59346	0	0
Otter Key		-0.60159	-1	0.60159
Island Park	800	-0.24184	-0.45494	0.62962
Longbeach		-0.67988	-0.60302	0.8592
Site	**Distance**	**C / A**	**P / A**	**C/ P**
Live Aboard				
Island Park	200	-0.29969	-0.39023	0.63957
Longbeach		-1	0	0
Otter Key		-0.38829	0.18056	-0.17103
Island Park	400	-0.34236	-0.36808	0.6604
Longbeach		-0.69557	-0.57282	0.75
Otter Key		-0.57742	-0.44842	0.07718
Island Park	600	-0.12545	-0.26204	0.60075
Longbeach		-0.31801	-0.52764	0.81832
Otter Key		-0.61842	-0.87946	0.46654
Island Park	800	-0.09909	-0.23041	0.56115
Longbeach		-0.42848	-0.40708	0.81832
Power				
Island Park	200	-0.1342	-0.27675	0.6493
Longbeach		-0.69557	-0.32733	0.5625
Otter Key		-0.66218	-0.539	0.76191
Island Park	400	-0.177	-0.26644	0.61296
Longbeach		-0.6296	-0.84483	0.50289
Otter Key		-0.02041	-0.4721	0.24638
Island Park	600	-0.16546	-0.27331	0.53696
Longbeach		-0.01376	-0.66055	0.08716
Otter Key		-0.07018	-0.58336	0.36873
Island Park	800	-0.06644	-0.19392	0.5538
Longbeach		-0.25118	-0.2944	0.05756
Sail				

Spearman Rank Correlation Results: By Activity				
Island Park	200	-0.18537	-0.21749	0.31888
Longbeach		-0.03252	-0.48703	0.16365
Otter Key		-0.18279	0.05403	0.89004
Island Park	400	-0.13872	-0.20995	0.21959
Longbeach		-0.40674	-0.33204	-0.09479
Otter Key		-0.3905	-0.07897	0.71181
Island Park	600	-0.07413	-0.02248	0.20521
Longbeach		-0.70365	0.02243	-0.1096
Otter Key		-0.4056	-0.20663	0.32873
Island Park	800	-0.04894	-0.02258	0.12339
Longbeach		-0.63566	0.07478	0.35238

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BIOGRAPHICAL SKETCH

Charles F. Sidman is a native of Lawrence, Kansas, who relocated to Florida in 1978. Charles spent several years in the work force before deciding to pursue a college degree. He earned a bachelor degree in anthropology from the University of Florida in 1989. Charles completed a master's degree in Urban and Regional Planning at the University of Florida in 1992. During this time, he held positions with the North Central Florida Regional Planning Council and the GEOPLAN Center at the University of Florida. Through the encouragement of Dr. Grant Ian Thrall and Dr. Gustavo Antonini, Charles entered the doctoral program in geography at the University of Florida in the Spring of 1993. Funding for Charles' doctoral program was provided by Dr. Gustavo Antonini, through employment at the Cartographic Research Laboratory in Applied Geography. Charles' research interests include GIS applications towards coastal management and planning. Charles is married, and has one child and two crazy cats.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Gustavo Antonini
Professor of Geography

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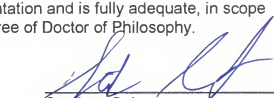

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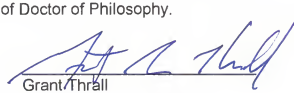

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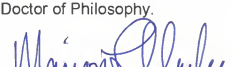

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Orjan Wetterqvist
Associate Professor of Urban &
Regional Planning

This dissertation was submitted to the Graduate Faculty of the Department of Geography in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December 1998

Dean, Graduate School